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# **Implementing DHIS2 Feedback via Short Message Service**

A Case Study for Uganda  
WEMR Health Workers

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## **Abstract**

Health Information System (HIS) plays an important role in a country's health system. Within HIS hierarchy, the data is collected from the lowest level and aggregated to the upper levels. Subsequently, the data is expected to be analyzed to form useful information and to be passed back to the lower levels for decision making and action taking on field. Such process to pass back the information down to the lower level in this study is referred as feedback mechanism. The regularity and timelines of the feedback is crucial for health workers on the ground, because getting obsolete feedback information may lead to incorrect action. However, this feedback mechanism does not seem to happen regularly and timely, especially in underdeveloped countries due to limited infrastructure (e.g. road, landline phone, electricity, Internet) as well as overburdened human resources which does not allow regular face to face feedback meeting to happen. On the other side, we have seen enormous penetration of mobile phone coverage which has surpassed landline phone coverage even in under-developed countries. Therefore, this thesis is motivated to study how wide mobile coverage can be utilized to bridge the gap in establishing regular and timely feedback mechanism by sending useful indicators via SMS down to health workers and evaluate how that impacts the way they work.

To conduct the study, a pilot project was implemented in Uganda based on existing District Health Information Software 2 (DHIS2) system that was enhanced further with newly developed SMS feedback capability. The results showed that SMS feedback solution is feasible in such low resource context. It was also shown that the enhancement was able to complement the current irregular feedback mechanism with regular and timely SMS feedback automation. In addition, the SMS feedback solution has been positively perceived by the health workers in several aspects: raising awareness/knowledge of current performance, motivating them to improve further and helping them to make informed decision. The health workers recognized the SMS feedback as useful and even proposed more information to be included. It was seen as good starting point towards nurturing information culture.

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## Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
ANC	Ante Natal Care
CAP	Complimentary Activity Package
CDC	Centers for Disease Control
CDMA	Code Division Multiple Access
CHW	Community Health Worker
DHIS2	District Health Information Software 2
eHealth	electronic Health
FeFo	Ferrum Folic
GPRS	General Packet Radio Service
GPS	Global Positioning System
HC	Health Center
HFS	Health Financing Strategy
HIS	Health Information System
HMIS	Health Management Information System
HISP	Health Information Systems Programme
HIV	Human Immunodeficiency Virus
HSD	Health Sub-District
HSSP	Health Sector Strategic Plan
HTTP	Hyper Text Transfer Protocol
HTTPS	Secure Hypertext Transfer Protocol
IPT	Interpersonal therapy
IRAP	Intermediate Referral Activity Package
ITU	International Telecommunication Union
IVR	Interactive voice response
JSON	JavaScript Object Notation
KAP	Knowledge Attitude Practice
MAP	Minimum Activity Package
mHealth	mobile Health
MMS	Multimedia Message Service



MNCH	Maternal, Newborn, and Child Health
MOH	Ministry of Health
MUJHU	Mackarere University-John Hopkins University
NGO	Non Government Organization
NHP	National Health Package
PDA	Personal Digital Assistant
PEPFAR	President's Emergency Plan for AIDS Relief
PFP	Private For Profit
PMTCT	Prevention of Mother To Child Transmission
PNFP	Private Not For profit
SIM	Subscriber Identity Module
SMGL	Saving Mother Giving Life
SMPP	Short Message Peer to Peer
SMS	Short Message Service
SWaP	Sector Wide Approach
TDMA	Time Division Multiple Access
UiO	University of Oslo
UNICEF	United Nations International Children's Emergency Fund
UNMHCP	Uganda National Minimum Health Care Package
VHT	Village Health Team
WAP	Wireless Application Protocol
WEMR	Web based Electronic Medical Record WEMR
WHO	World Health Organization

# 1. Introduction

With the proliferation of computer and information infrastructure, many countries have started implemented electronic health data reporting, including Uganda. On the field, the health workers perform data capture by paper, fill up the electronic form and then submit it. Data aggregation will be done electronically as well, which typically starts from district level up to national level. The existence of electronic HIS has been speeding up the data processing vertically up to the national level, and hence allowing the country health ministry to monitor the country health status and make appropriate national level planning and decision.

However, the intent of HIS is not only for provincial or national level planning and monitoring, but also down to facility level evaluation and decision making. Facility needs to get information on how they perform compared to average, against the target or over certain time period. Similarly, the information is expected to reach health workers on the field as well, so they understand what is going on beyond just what individual health worker is doing. This is commonly referred as feedback mechanism. Unfortunately, such feedback mechanism is not always occurring. There are various known reasons, such as: 1) dissemination of paper based feedback down to facility level requires long turnaround time due to transport problem, which makes the feedback obsolete and not relevant anymore, 2) not all facility has adequate electricity supply and Internet connection, making feedback by email is not always feasible, 3) limited resource and time on overburdened health system with various priorities, which does not allow regular face to face feedback mechanism to happen

The penetration of mobile phone into developing countries like Uganda has opened a possibility of new way in implementing feedback mechanism. Although different mobile handset may have different features, they share a common and standard feature which is Short Message Service (SMS). It exists even in the cheapest handset. The focus of this thesis is to learn whether sending feedback by SMS to facility health workers and supervisors will make any beneficial impact to the way they work in the ground level.

As a part of the study, an SMS feedback functionality was developed in DHIS2, the system that Uganda uses as national HIS system. After the functionality has been developed, then we would test it in a pilot project. The Uganda WEMR program is targeted as the setting in this case study. After certain period of pilot testing, we would start collecting the feedback from the participants using questionnaire. Finally the result will be analyzed to answer the research question.

## **1.1. Motivation**

There are several motivations to choose SMS feedback as topic of this master thesis.

First, we understand from literatures and previous studies that closed-loop feedback process has important role in a health system. After aggregated data has been collected and analyzed, it can be used to make decision and follow it up with action. Such decision making and action taking can be done at any level, including health facility at lowest level as the frontline of health service. Therefore, timely feedback down to health worker could be beneficial to help them to take the necessary actions in time. In fairness, not all decision or action can be derived from every feedback, but at least the feedback may provide useful information which in longer term may help cultivating information culture at health worker level.

Second, from technical perspective, feedback by SMS is not yet supported in standard DHIS2 today. DHIS2 (District Health Information System 2) system itself has been endorsed by World Health Organization (WHO) as a national data warehouse approach to HIS, with the objective of facilitating aggregate reporting at different levels [49]. DHIS2 has been used in many countries, especially in developing countries (47 countries when this report is written), and therefore enhancing DHIS2 with this capability could potentially benefit many implementing countries. At the moment, there is SMS functionality in DHIS2, but it is more as reminder functionality related to patient tracker. For instance, a pregnant woman can be registered to antenatal/postnatal care program and her visits are planned and tracked, in such a way that DHIS2 will be able to send SMS reminder when the visit is due or late. However, that present SMS functionality does not cover ability to send feedback on how certain indicator performing at aggregate level, which is important for evaluation. So this project will provide contribution to DHIS2 as the software package by adding new capability. More discussion on DHIS2 will be covered in chapter four and chapter five.

Third motivation is that HISP Uganda has shown interest in SMS-feedback capability. As background, HISP (Health Information Systems Programme) is the umbrella organization that develops and implements DHIS2. It is a global action network that is coordinated by the Department of Informatics at University of Oslo (UiO). HISP Uganda is one node of global HISP network, aside from some other notable network nodes such as HISP Vietnam, HISP Kenya, HISP India, HISP Rwanda, HISP Nigeria, HISP East Africa and HISP West Africa. With HISP Uganda interest in SMS feedback, we have real world use case from their need. This real use case then can be used to validate the applicability of theory mentioned in literatures, whether feedback to Ugandan health worker would have

similar impacts to what have been mentioned in previous studies, or perhaps has distinctive impacts which could be local phenomenon in Uganda setting. Therefore this project may provide contribution both to Uganda HISP program in practical and also contribution to the knowledge building around SMS-feedback. More detail on HISP and HISP Uganda is elaborated in chapter four.

Last but not least, other countries have expressed similar interest in such SMS-feedback functionality out of DHIS2, for example South Africa and Timor Leste. Therefore deliverables and findings in this master thesis project could be beneficial and leverage able to other countries. We can learn what works well and what does not work so well, to make better implementation in other countries.

## **1.2. Research Questions**

We structure the research with one main research question and several supporting sub research questions. The main research question is how sending SMS-feedback to health workers involved in Uganda WEMR program would impact the way they work. This is an exploratory research question, as at this point the scope of impact is open and not limited to certain aspect (e.g. motivation, performance, perception of work, work satisfaction etc.).

As finding out the impact requires the SMS-feedback functionality to be available, then the first sub research question will be how we should develop the SMS-feedback functionality in DHIS2. This is a more technical question that links to DHIS2 functionality and architecture. Also, since WEMR has been an existing system with its users and interconnected systems, it is important to understand what kind of strategy that we need to use to approach the development process to ensure it does not break the existing capabilities while adding new functionality.

After the functionality has been developed, the next step would be to determine the appropriate SMS feedback message. The question would be what kind of feedback information is deemed useful to health workers' duties at fields and in what way the usefulness is. For example whether it helps the health worker to become more productive, more motivated, more knowledgeable, understand better on the work priority or anything else. Similar question is applicable to the leader/supervisor as well, what kind of feedback information is deemed useful to their duties as leader/supervisor, whether the feedback information may be useful in helping supervision, monitoring and decision making purpose.

Lastly, every implementation may have challenges or even negative impacts. So it is also

interesting to find out whether there is negative impact and challenges. If there is, how we should mitigate the impact and overcome the challenge.

### **1.3.Target Audience**

This project report is targeted for several possible audience. First and foremost is for HIS implementing organizations, which have interest in implementation of SMS feedback mechanism in general. We hope that the findings of this project could provide learning points for future SMS feedback implementation in their organizations to enable smoother and more successful implementation.

Secondly, this project report is targeted for DHIS2 communities in particular. As SMS feedback is implemented for the first time in DHIS2, this project can be used as starting point for improvement to make better or more generic SMS feedback solution. We hope that the current solution can be leveraged to many other countries which use DHIS2 today with some possible localizations adapting to individual countries' requirements.

Lastly and more importantly, we target this project report for any HIS practitioner who have interest in exploring SMS feedback impacts to health workers at the ground. We hope that the findings on the impact can contribute in knowledge building around SMS feedback implication in general.

### **1.4.Thesis Structure**

This thesis report is structured into seven chapters. First chapter contains introduction which provides context of the research and brief explanation of what the research is about. It highlights the initial problem around lacking timely feedback mechanism which triggers this research. Next, it explains the motivation as to why we think the topic is interesting and worthy for research. Lastly this chapter also details out what questions this research wants to answer, broken down into one main research question and several supporting sub research questions.

Second chapter covers current knowledge base from existing literatures and previous studies. The literatures and previous studies provide the theoretical stand point and learning resource as supporting guide for the research. They highlight what have been done before and known knowledge around feedback mechanism, such as why it is important and how it could possibly be done. One topic is around mobile health solutions using SMS, where we investigate both theoretical solution and several practical

implementations, and what learning points we can take away. Another important topic is about health worker motivation itself, to understand what factors contribute to the motivation in positive and negative ways. We will also try to look at how feedback mechanism have been done in previous implementation studies, whether it is based on physical copy, computer based electronic report or mobile phone based. Finally we will look at relationship between feedback mechanism to information culture building among health workers. In addition, since Uganda has been using DHIS2 as existing health information system along with other local systems to form health information infrastructure, we will also discuss about theoretical ground as to how we should design new elements over existing information infrastructure, which covers bootstrapping and cultivation.

The third chapter elaborates methodology that is used in the research. This project is based on action research and case study approach. The action research is inherited from HISP program as the umbrella organization for DHIS2 development and implementation. The project is aiming at both solving practical problem by providing solution to meet the need in Uganda and also contributing to knowledge building around SMS-feedback. The case study approach is taken because the pilot testing is conducted in limited setting under Uganda WEMR program. Therefore any finding is subject to the study case boundary and may not be necessarily valid in different setting. It is also important to note that the author, while developing the software and contributing to asking questions to WEMR team, did not personally visit Uganda to conduct direct field work due to work related reason. Therefore the interaction and communication with WEMR team were done electronically. Some field information are based on data obtained by fellow student working on similar topic who went on trip to Uganda.

Chapter four discusses the background and empirical setting of this thesis. It describes Uganda as a country and its health system situation. It also elaborates DHIS2 and HISP presence in the country, as well as explains what Uganda WEMR program is about, its objectives and how it is run.

The fifth chapter describes the findings of the project. First, the chapter explains the findings around the system development of SMS feedback capability itself. This is something more technical as to how we learn DHIS2 architecture and program codes, and then to come up with new SMS feedback solution. Coming up next, this chapter details out the testing phase of the SMS feedback with WEMR health workers. It provides description how the testing is setup and run. Lastly, the chapter tries to analyze the testing

result and come up with the findings on the perceived impact of sending SMS feedback to health worker and supervisor during the testing period.

Chapter six provides discussion. It puts this project into perspective and contextualize its contribution in SMS feedback knowledge area. It describes what the findings tell and where the findings are relevant for whom and for which reasons. This chapter relates and positions this project within literature space and what limitation it has.

Chapter seven, the last chapter, draws conclusions. It sums up the outcome of the project with summary of research questions, findings, main problems and what they lead to. It describes the implication of the project findings and also possible directions for further research.

## **2. Literature Review**

In this chapter we look at existing literature and previous studies related to feedback in health system and mobile health (mHealth) solutions including SMS usage. We also look at factors influencing health worker motivation as well as information culture at health worker communities. The literature and previous studies are used as the theoretical stand point and also as learning resource to support the research.

### **2.1.mHealth Solution**

#### **2.1.1.What is mHealth?**

Per WHO mHealth is defined as “the use of mobile and wireless technologies to support the achievement of health objectives” [1]. The mobile devices may range from mobile phone, smart phone, tablet, PDA and other mobile communication devices. The word “support” in this definition is key, because mHealth is most appropriately understood as a tool for promoting healthy behaviors and strengthening health systems.

mHealth field is seen as subset of eHealth, which is defined as “the cost-effective and secure use of information and communications technologies in support of health and health related fields, including health care services, health surveillance, health literature, health education, knowledge and research.”

eHealth is a more general term which consists of:

- Mobile Health (mHealth): as defined above.
- Health Information Systems (HIS): Systems to gather, aggregate, analyze and synthesize data from multiple sources to report on health; can include information related to patient records, disease surveillance, human resources, management of commodities, financial management, service delivery and other data needed for reporting and planning purposes.
- Telemedicine: Provision of health care services at a distance; can be used for inter-professional communication, patient communication and remote consultation.
- Distance Learning (eLearning): Education and training in electronic form for health professionals.

#### **2.1.2. Type of mHealth solutions**

There are broad ranges of mHealth solutions. Technically, the solutions utilize the capability of mobile devices in delivering health information, freeing us from limitation



in wired-infrastructure. The information can be delivered in several ways including Short Message Service (SMS), Multimedia Messaging Service (MMS), Interactive Voice Response (IVR), audio & video communication, audio & video clips, mobile device camera, mobile web browser (GPRS/WAP), mobile apps, digital forms and any sensors attached to mobile devices (e.g. accelerometer, GPS etc.).

In terms of infrastructures and equipments/devices, some mHealth solutions require more sophisticated resources, such as video and sensor based solutions. Some others just require less sophisticated resources (i.e. low resource). Low resource mobile solutions are typically more feasible to be implemented in developing countries, including Uganda. As far as low resource context is concerned, Sanner et al [50] categorized the solutions into four categories: IVR, plain SMS, mobile handset/SIM application and browser based solution, with their own strengths and disadvantages. While mobile handset/SIM application may use SMS as data transport mechanism as well, this SMS feedback project does not use such approach, but rather we take plain SMS approach only.

In terms of the purpose/usage, WHO mHealth report [1] classified the application of mHealth solutions into several groups which are: health call centers, toll-free and non toll-free emergencies, mobile telemedicine, appointment reminder, community mobilization, treatment compliance, patient record, information, patient monitoring, health survey, surveillance, awareness raising and decision support system.

Labrique [2] together with a group of mHealth researchers and implementers from Johns Hopkins University, UNICEF, WHO and Frog Design, proposed twelve classifications of mHealth application, namely: 1) client education & behavior change communication, 2) sensor & point-of-care diagnostics, 3) registries & vital events tracking, 4) data collection & reporting, 5) electronic health records, 6) electronic decision support, 7) provider-to-provider consultation, 8) provider work planning & scheduling, 9) provider training & education, 10) human resource management, 11) supply chain management and 12) financial transactions & incentives.

As can be seen above, mHealth offers very broad range of solutions to support health service delivery. However, the focus of this thesis is more towards health service provider education. With indicators being feedback via SMS to health worker regularly, we anticipate certain level of education and supervision to indicate how they perform. Getting such information may help creating information culture among

health workers as well. Aside from that, it also opens up possibility to support better informed decision making process for the manager/supervisor.

#### 2.1.3. Adoption of mHealth solutions

Various mHealth solutions have been implemented in all regions around the world. WHO mHealth 2011 report shows that 83% of its 112 member states have at least one mHealth initiative in their country. Of that 83% countries, most member states reported implementing four or more types of mHealth initiatives. Countries in Africa region reported the fewest initiatives while countries in South East Asia reported the most. It is understandable because mobile infrastructure in Africa is the least developed compared to other regions, making it one of reasons for having fewest mHealth implementation.

As per the report, the types of mHealth initiatives most frequently implemented globally are health call centers/healthcare telephone help lines (59%), emergency toll-free telephone services (55%), emergencies (54%), and mobile telemedicine (49%). These mHealth initiatives share the common characteristic of using the core voice functionality of a mobile device. Whereas the least reported initiatives are health surveys (26%), surveillance (26%), awareness raising (23%) and decision support systems (19%). From the figures above, we can deduce that mHealth has been used more in curative activities (i.e. post mortem intervention to cure the health problems) than in preventive activities (i.e. to prevent new health problem).

#### 2.1.4. Why mHealth?

The flow of health information from source to recipient is crucial in supporting health services deliveries. Theoretically the faster transmission and the more complete information availability will enable patient and health providers to make decision and take necessary actions in more accurate manner. The traditional way of transmitting information using paper has been seen as prohibitive from cost and time perspective. The use of electronic medium to transmit the information has opened possibility to overcome the time and speed issue, such as using computer and Internet-based solution e.g. email, web reporting etc. However, the required infrastructure in developing countries may not be ready to support such Internet-based solution, such as limited electricity infrastructure as well as limited wired Internet connectivity. Therefore we see the need for other solution that does not rely heavily on such infrastructure but provides deep enough penetration to rural areas.

In the contrary, World Bank reported in 2012 [3] that three quarters of world population have access to mobile phone and therefore the story is not about the phone itself but more about how it is used. With such extraordinary phenomenon on the exponential growth of mobile communications, whereby such technology is bypassing conventional wired system, we see this mHealth solution as a very possible way out and a strong argument on why we need M-health. It is much easier to build a tower for mobile communication than connecting fixed line network to reach rural area.

Aside from cost advantage of mobile solution, Kumar et al [4] suggested the mobility aspect of the device brings possibility to support more continuous health monitoring at both individual and population level. It also may reduce the number of healthcare visits and provide personalized and on-demand interventions.

#### 2.1.5. mHealth barriers

Despite of promising advantages over other traditional approaches, mHealth has several barriers to implement. WHO report [1] suggested, the biggest barriers are competing priorities (52%), followed by lacking knowledge, unsupportive policy and unclear cost effectiveness. Whereas the least barrier is infrastructure (26%), followed by lacking technical expertise and lack of mHealth solution demand itself.

Looking at this result, it is evident that mHealth is technically seen as feasible solution, but it is not implemented because it is not considered as something that needs to be prioritized. Many health systems in various countries are overburdened and over stretched with multiple health issues and so they allocate the funding and resources more to tackle such health issues which have direct results rather than to implement mHealth. This lack of general interest in mHealth is understandably due to lack of strong evidence-base to verify its impact on health outcome of the health system.

We think that lack of interest is somehow related to the second highest barrier, lack of knowledge. They may not be interested because they might not know what mHealth solutions have been implemented in other side of the world and to what health outcome as result. Various mHealth implementations have been done locally around the world, however there have been limited global studies which can provide general knowledge that can be disseminated to other countries with similar settings.

As a result of minimum knowledge and interest, as well minimum evidence on the benefit, it is sensible that the governments might not even think about creating policies

that could promote mHealth, such as policy to provide incentives for health organization and mobile operator to get involved in mHealth initiatives.

#### 2.1.6. Empirical evidence to support mHealth

The availability of empirical benefit is important to mHealth initiatives, especially in low and middle income countries with limited amount of funding and resource. Such condition necessitates them to spend it on the right priorities initiatives in which they are sure to get concrete benefit. Unfortunately, Philbrick [41] suggested that the majority of published articles on mHealth were descriptive in nature. Less than one-third of articles he studied using proper experimental design and often most of them were conducted with pilot in small sizes and lack of rigor.

Tomlinson [43] also argued that the current evidence is insufficient for scale-up. For example it was reported that in Uganda between 2008 and 2009 approximately 23 of 36 mHealth initiative did not go beyond pilot. He suggested that the required evidence to support scale-up should meet efficacy trials (ideal conditions, typically in pilot) and effectiveness trial (real-life conditions). Likewise, Heerden [45] also argued that mHealth needs to develop evidence base, as he quoted that in 2008 literature review it was revealed that 84% of the published programme were prototypes, pilots or tests.

Concurring with those findings, Labrique [1] in his paper suggested that albeit many pilot mHealth projects, there is still limited large-scale mHealth implementations due to minimum empirical evidence supporting their value in terms of cost, performance and health outcomes. It is understandably difficult to isolate the individual factor, including mHealth presence, to the overall health outcomes because one and other factors contributes collectively to the result.

Labrique argued that rather than measuring the health outcomes as direct impact of mHealth, it is more sensible to see mHealth as tool or enabler to overcome constraints to delivering good health service. Therefore it is not necessarily about the final result in health outcomes, but more on the delivery quality of the health services, whether the constraints that prohibits the service delivery can be reduced by mHealth solution. So we should see mHealth as catalyst function.

Labrique proposed a framework to identify and synthesize the evidence of mHealth solution impact. The framework suggested an approach to map the mHealth solution into following dimensions: 1) the health system constraints or challenges that the

solution is trying to address; 2) the interaction between mHealth solution and health system actors, including location, timing and data exchange.

The framework starts with the beneficiary target of the mHealth strategy (who is the patient) and what type of essential interventions is required. This helps in maintaining focus on the health system needs that the mHealth solution is trying to facilitate, rather than on the technology being used. After that, we need to identify what constraints that mHealth solution is addressing, for example timelines of care, delayed reporting of event etc. Then finally we need to map the “touch point” between health system actors with the mHealth solution. The proposed framework provides a way to articulate individual mHealth project in a more structured way by visualizing it, and also facilitates the identification of gaps where future projects may be needed. Consensus on such framework, if can be used commonly, will help scattered mHealth projects to communicate the values and to generate the evidence to support mHealth solution in more standardized way. However although there is no consensus on the framework yet, there have been efforts made to facilitate information sharing of previous implementations, such as one provided by mHealth Alliance under domain “mhealthknowledge.org”.

#### 2.1.7. Current situation on mHealth evaluation

Evaluation is vital component to ensure mHealth continuity and success. Without evaluation, it is difficult to measure whether the initiative is on right track and generating value. Unfortunately, as reported by WHO, only 12% countries globally have evaluated their mHealth initiatives. In lower income countries, only 7% of them conducted evaluation. In high income countries, around 23% of them performed the evaluation. The high income countries typically have mature and more continuous mHealth initiatives and most likely to be conducting evaluation built within the project management plan. The low level of evaluation is reflection that mHealth is still a growing area and evaluation process is still not considered as priority at the moment. With minimum evaluation, it will be difficult to build the evidence-based knowledge whether the initiatives generate value, and to provide lesson learnt for future implementations by others.

It is often that the evaluations still focus on the usability, to see whether the mobile technology can be used and working well on the field. If the solution does not work, the evaluation will try to find out what can be done to make it works, for example bug fixing, providing more user training, improving change management process etc. To

some degree it can be said that if the solution works then the initiative is considered successful, and therefore evaluation serves a purpose. However, the bigger question is actually what contribution the working solution has made in improving the health outcome or what health delivery barrier has been solved by the working solution. Those questions are not always evaluated and in the end it provides only technicality learning but not necessarily value and cost-benefit learning. The latter, cost-benefit evaluation result, is more important for informing others and would help them in considering whether mHealth solution is worthy in their settings and whether it will improve their health outcome.

Other challenge is that how we can evaluate and benchmark the solution from one implementation and another. Currently the evaluation and evidence are sparse for efficacy of mHealth solution. To facilitate “common language” for evaluation, it is suggested to have shared metrics or more standardized evaluation indicators for monitoring to be agreed upon. A preliminary work has been taken in a small study initiative conducted by WHO in collaboration with Earth Institute, Columbia University. The study set common metrics and applied it to a survey on mHealth evaluation. In that study, Mehl [5] proposed evaluation metrics that focus on costs, sustainability, behavior change, health outcomes, knowledge/ attitudes/ intentions, provider performance, quality of care and service utilization. From the study it was identified that several evaluation assistance questions were commonly coming up, such as “we need a systematic approach to analyzing the data we have collected over the past 3 years”, “we also need to learn what is the norm for ‘success’ in this field and how we stack up to normal intervention vs other mHealth projects working on [similar] technology”, “we need guidance on evaluation methods for mHealth”, “we are interested in collaborative approaches and standard indicators that will be measured across the different mHealth programs” and “how to assess the impact of our mHealth tool”.

#### 2.1.8. Implementation guideline

In response to such implementation knowledge gap, with respect to eHealth in general (which is also applicable to mHealth as the subset), WHO and ITU has provided a strategy toolkit which serves as a framework and method for the development of a national eHealth vision, action plan and monitoring [35].

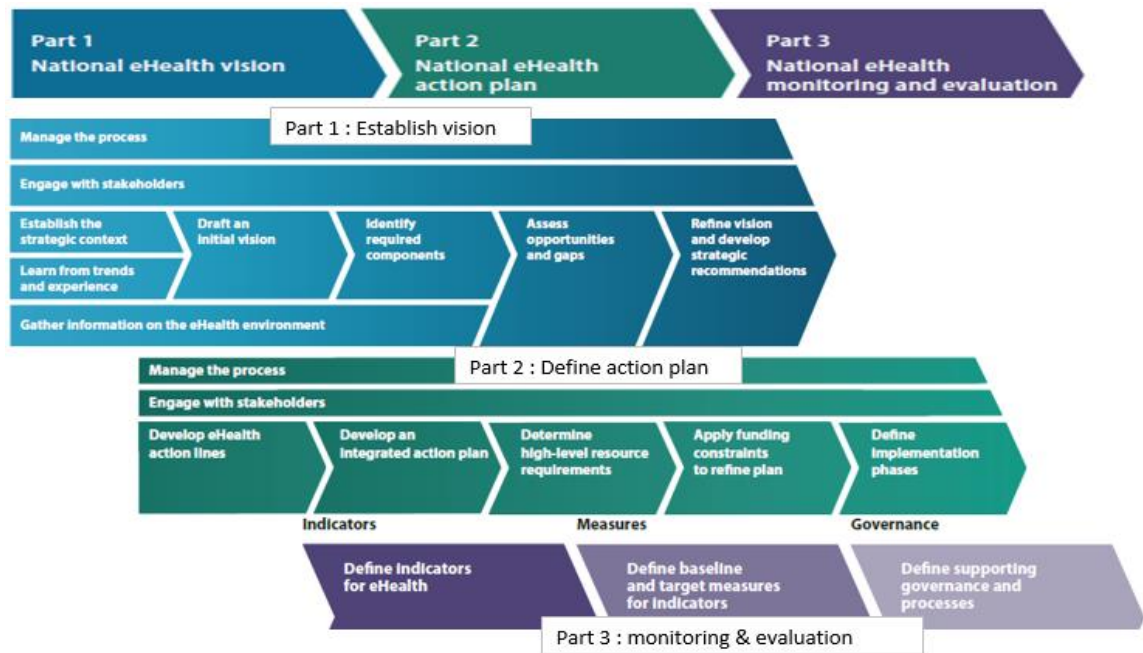


Figure 1. WHO & ITU eHealth implementation guideline overview

The guideline serves as a resource that can be applied by all governments that are developing or revitalizing a national eHealth strategy, whatever their current level of eHealth advancement. The first part provides framework to define a national eHealth vision that responds to health and development goals. This part contains an important step to learn from trend and experience as input before drafting initial vision. The second part discusses about national eHealth action plan that reflects country priorities. Resource requirement and funding constraint play vital role in determining action plan. The third part covers plan to monitor implementation based on indicators and baseline measurements, as well as to manage associated risks with a good governance. mHealth as subset of eHealth can take the suggested implementation guideline above. Within mHealth itself, there is SMS based solution which we will discuss in the next section.

## 2.2. SMS Usage within mHealth solutions

### 2.2.1. SMS solution advantages over other mobile solution

SMS has been the most widely used as medium of information exchange using mobile phone, after the voice call. First and foremost reason is due to the fact that it is supported by all type of mobile phone handset, from the lowest end to the more sophisticated smart phone. Low and medium income countries' population, such as population in rural African countries, typically cannot afford buying smart phone.

Therefore, other type of solution such as video, MMS or mobile apps that requires Internet connection would not be suitable in such setting.

The maturity of SMS protocol also an advantage, whereby the plain text sent by the sender will be received by any receiver in the same way, as long as the code-page adheres GSM 7-bit alphabet code page, without using special characters (e.g. Arabic, Chinese, Korean etc.) that requires 16-bit encoding which may not be supported by all mobile phone. Therefore the chance of information loss or information misinterpretation is relatively low.

Another big advantage of SMS is the cost. Cost to send SMS is relatively cheaper than other service such as voice, MMS, video or Internet via GPRS. Using SMS aggregator provider, such as BulkSMS or Clickatell, one SMS may cost as low as 5 cent USD. That makes SMS solution is more affordable from SMS mHealth implementer's point of view, allowing them to finance the solution sustainably.

SMS also demands minimum stability in network connection and coverage. Whenever network is unavailable, the information is still kept at the operator central message center, and it will keep try resending until the mobile phone is connected to network. Therefore the information will not be lost though delivered in delay. SMS also works on the basic voice network and is adopted by the big three type of network: GSM, CDMA and TDMA, making it a universal service. In comparison other solution such as MMS, video or Internet requires more network stability and coverage, whereby intermittent connection may lead to information loss.

Lastly, as the most common feature of mobile phone, most of people knows how to use SMS service. Therefore unlike other solution, such as Java application or mobile app that requires user training, reading and sending SMS is much easier, and that makes the focus shifted more towards familiarize user on how to encode and decode the message in the right format as per solution specification. Hence it reduces training effort requirement and incorrect usage possibility, at least when the amount of data to be handled is relatively small.

#### 2.2.2. SMS solution constraints

Despite of its many advantages, SMS is limited in message length. Generally it is up to 160 characters. If the message is longer than 160 characters then it will be split into two or more SMS. Therefore, sending rich information over single SMS will be a challenge and may require certain encoding or abbreviation. Such encoding or abbreviation may need to sacrifice user friendliness from human point of view.



As consequence of being text only, it has limitation in describing certain message that naturally demonstrates visual information (e.g. pictorial or video learning). It is also limited in facilitating rapid two ways interaction such as consultation between patient and health worker by mobile phone. SMS still can support two ways communications though, but it may not be as rapid as voice communication.

Other constraint is SMS recipient must be literate person. In low income countries, especially in rural area, there are still considerable population whom are illiterate. They may use mobile phone, but more to make or receive calls instead of SMS. Therefore sending SMS to such population may not necessarily get the expected outcome.

### 2.2.3. SMS based mHealth implementations

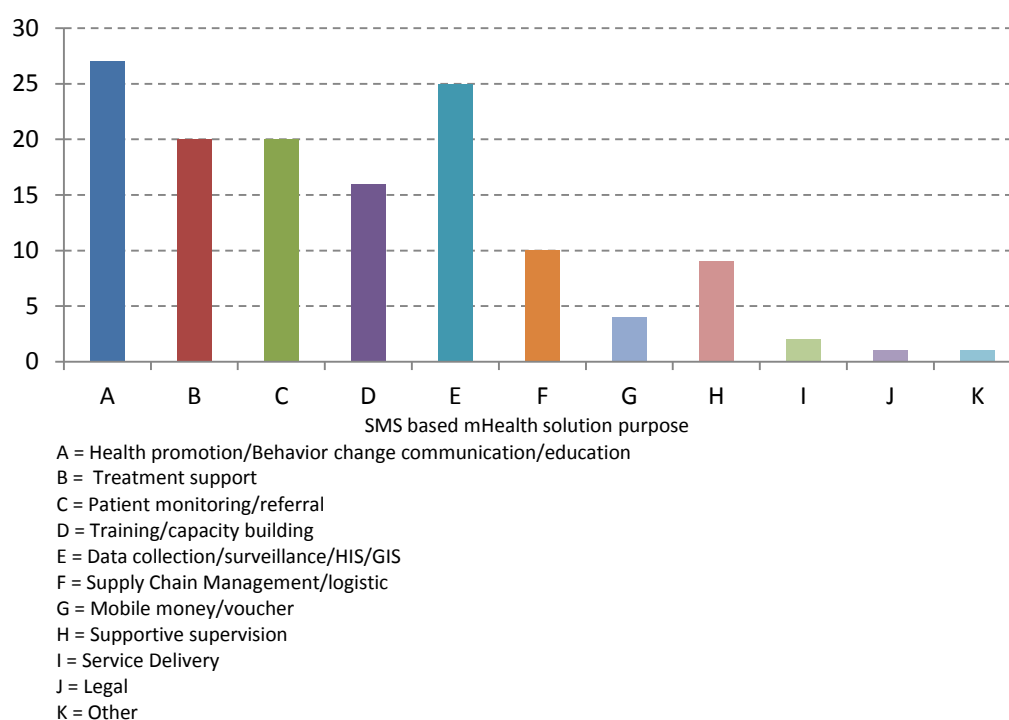
There has been an effort today to inventorize mHealth initiatives around the world. One of organization which tries to collect such information is mHealth Working Group. They have been maintaining list of initiatives, which everybody can register for any new project into the repository. As of now when this report is written, there has been more than 400 mHealth initiatives registered globally, at different stages of implementation. Some initiatives are pilot testing, some others are full scale implementation, some others are completed initiatives and some are still in requirement gathering/design. Out of them, 37% mHealth initiatives utilize SMS as information medium, among other mediums which may be used in parallel.

SMS based mHealth solutions have been implemented for various purposes. Out of 157 SMS based mHealth solutions registered, the majority is used for health promotion/education & behavior change (17%), data collection /surveillance (16%), treatment support (13%) and patient monitoring / referral (13%) as depicted in the below chart. Those solutions are mostly targeted to public population as the beneficiary of SMS mHealth services. This is very understandable, because public population as the target is likely having closer or direct correlation to the public health outcome.

There are some SMS mHealth solutions which target the health workers as the beneficiary, such as training/capacity building (10%) and supportive supervision (6%). In contrary to the earlier categories, these solutions have indirect correlation to the public health outcome. The expectation is, however, by improving skills and motivation of health workers, the health services to public will be delivered in better quality. With better quality of health service delivery, indirectly the public health outcome is expected to improve. Similar to that, some SMS based mHealth solutions

are addressing supply chain/logistic issue (6%) to prevent drugs stock out issue. These health worker and supply chain improvement initiatives are seen as enabler or catalyst for better health outcome.

Uganda in particular has been using SMS based mHealth solutions in several projects. For example in malaria monitoring program as described by Asiimwe [35] and PMTCT in Option B+ program.



*Figure 2. Number of SMS based mHealth solutions by purpose  
(mHealth project inventory by mHealth Working Group, March 2015)*

#### 2.2.4. SMS based mHealth results

Based on various case studies, majority of SMS based mHealth solutions results were seen as positive. Most of the studies suggest that SMS based solution are usable and feasible, mainly measured by number of sustained participants. As for the result measurement, however, it is common that proxy indicator is used instead of the final health outcome. It is understandable as the function of SMS is to bridge communication gap to convey health information, rather than delivering the health service itself. Therefore the final health outcome involves various factors beyond just

information delivery. The proxy indicators can be qualitative or quantitative. Qualitative proxy indicators are typically based on interview or survey which were conducted after the implementation to get the beneficiaries perception, whether they feel the value. Whereas quantitative proxy indicators are typically based on the number of actions or responses against the SMS. For example the number of patient's attendance, percentage of missed-out appointment, number of baby delivery with health worker's attendance etc. Whether the final health outcome, such as morbidity or mortality etc., has improved or not is something considerably difficult to find out due to indirect correlation and typical limitation of study duration.

## 2.3. Feedback in Health System

The terminology “feedback” in this report is referring to the flow of analyzed health information from higher level back down to lower level, typically required for action-based use. This is the opposite direction of the flow in data aggregation and analysis process, whereby raw data is originally from lower level and gets aggregated all the way up to the higher level. The definition of higher level and lower level are relative in nature. For example district level is higher compared to facility level, but it is lower compared to provincial level. Therefore feedback in this case could be, for example, the flow of health information from provincial level to district, from district level to health facility and so on. It could also be straight from national level down to health worker or public population.

### 2.3.1. Basic Information Flow in Health System

Abou Zahr [6] in World Health Organization bulletin described the data needs and sources at different levels as in figure below.

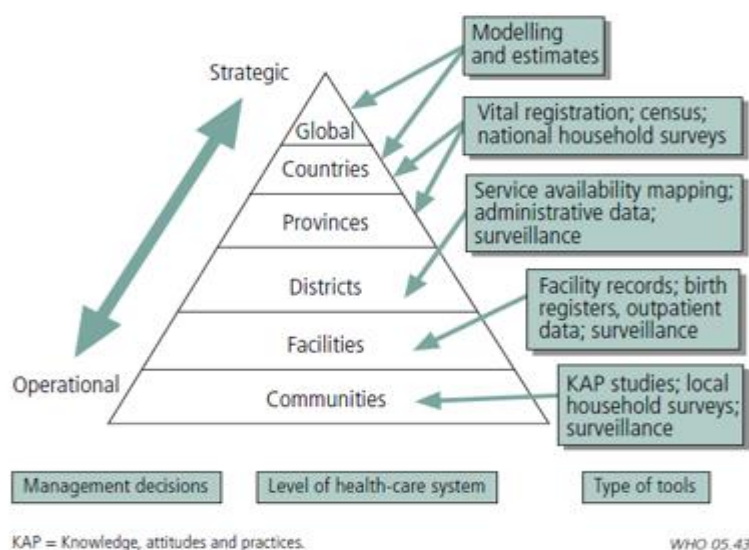


Figure 3. Data needs and sources at different levels of health system

The higher the level is, the more strategic activities are performed. On the contrary, the lower the level is, the more operational activities are performed. At community level, which is the lowest, KAP (knowledge, attitudes and practices) studies, surveys and surveillances are performed to collect the data. At facility level, data collection still can be performed, such as birth registers, outpatient data and facility specific records. Data from communities and facilities will then be aggregated to district level all the way to province and country level. At district, province and country level there could be some data collection activities (not from lower level aggregation), such as census. The aggregation at top level combined with census will be used to perform modelling, forecasting and estimating to support health policy making and other strategic measures.

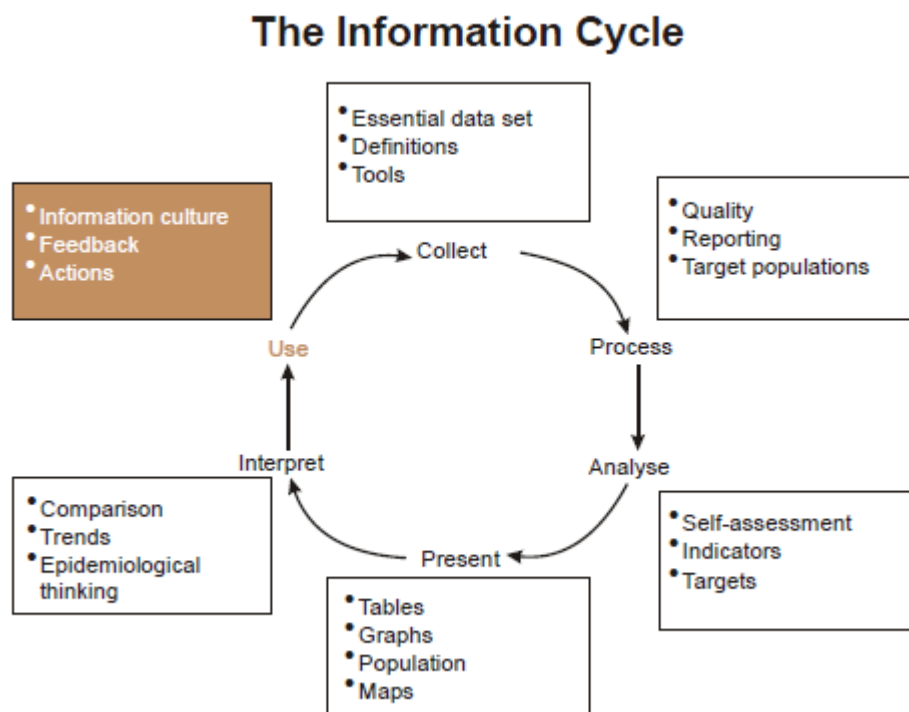
However, health information at any levels need to be analyzed, used for decision making and converted into evidence-supported actions. Information is collected for use, not just for the sake of formality. That is where we operationalize the information. The strategic and operational activities must be aligned each other. Operational activities provides data to support analysis in strategy making; whereas the strategy provides policies and directions to perform the required operational interventions, cascaded down from one level to the subsequent lower levels. With that alignment, the expectation is that the strategy can effectively answer the needs on the ground and the operational interventions in the ground have clear focus on what to be done according to country priorities. The need for such alignment is even more crucial for low and middle income countries, because they do not have luxury on funding and resources. Therefore whatever operational interventions to be taken must accurately answer the real demands on the ground with less room for inaccuracies due to all the financial and resources constraints.

Bodart [7] suggested that in decentralized health system, one level of the system should provide feedback and supervision to a level below. He mentioned that regional/province level should provide feedback to district on consolidated and analyzed data. Likewise, district level should provide feedback and to supervise facilities in the district.

### 2.3.2. Importance of Feedback

Heywood and Rohde [8] described the information cycle as on figure below. After data has been collected, processed, analyzed, presented and interpreted then the next most

critical step is to use it. The use of interpreted information contains three aspects which are: actions, feedback and information culture.



*Figure 4. Information cycle within health information system*

Actions on the fields must be well pre-informed. Every decision made and every change must be guided by information, therefore we need up-to-date information at any time. Outdated information may not produce useful decision and action, hence may not provide the expected result when implemented on fields. Therefore, timeliness is a key.

The use of information to support decision making and to drive the action does not come easily. There are many cases where information is available but it is not used. This has been described as a culture of reporting rather than a culture of using, as described by Byskov and Olsen [9]. Unfortunately, there has been little tradition of information use for decision making at facility level in developing countries. Several studies reaffirmed that case, such as study by Odhiambo [10] in Kenya and Stoops [11] in South Africa

Information use is made easier if it is ritualized and habitualized as part of “information culture”. To build such information culture, however, it needs a long process. Such culture would emphasize that “information must be used, and no decision/action made without information support”.

Feedback is considered as communication of analyzed information and interpreted in local context. If the purpose of information is to inform the actions of potential users, then feedback is the most important mechanism to achieve the purpose. Feedback is required at every level to know how they have performed. Without feedback we will not know where we are. The comparison in the feedback can be:

- a. based on target/priority, whether we are on-track for target/priority or not
- b. based on peers, whether we are above or below peers
- c. based on past performance, whether we are better than before or even worse
- d. based on standard procedure, whether we comply/adhere the defined standard procedure

Aside from feedback to health workers, such feedback is also applicable to public population as well for education purpose. Public population needs to know how they should improve.

### 2.3.3. Feedback to Health Worker

Feedback is basic right of health worker, as it serves as a kind of training and reflection on how the health worker performs. Feedback to health worker may take many forms, but would be best to be done in writing and discussed. However, verbal feedback is also valuable when written one is not possible.

Supervision is the most important form of feedback. Supervisory visits ideally would focus on information analysis, interpretation and action planning. The supervisor brings the feedback based on previous period or based on target which has been analyzed and interpreted. Together with health worker, the information is discussed to agree upon next action plan, which will be evaluated again in the incoming period.

Unfortunately such feedback mechanism does not always happen, for example in Kenya as described by Odhiambo [10] or in South Africa as described by Garrib [12] or in Pakistan as mentioned by Lippeveld [13]. Garrib reported that no feedback from district to clinic supervisor and from supervisor to clinic staff which caused unawareness of clinic's performance in relation to national targets or to other clinics. One factor causing the feedback absence is human resource shortage with skill to perform analysis and generate the feedback. Therefore, the data which have been collected and aggregated just remain unused data and not convertible to actionable information at health worker level. In the end, the expectation is to continually improve the quality of care.

Another downside of feedback absence is that the health worker will not be aware of importance in collecting and submitting the data. They will feel the effort to collect and submit data is merely useless. Eventually, it may erode the motivation in continuing data collection and submission, as they do not feel the benefit of it, rather just feeling additional workload aside from attending the patient. In turns, the lack of feedback and supervision may deteriorate further the quality of data collection, as suggested by Mavimbe [14]. Thus, it may create a systemic path to failure in the overall health information system, bringing everything down.

## **2.4. Motivation and Information Culture among Health Worker**

### **2.4.1. Motivation**

A study by Franco [15] suggested that worker motivation is a complex process and crosses many disciplinary boundaries, including economics, psychology, organizational development, human resource management, and sociology. Health sector performance is critically dependent on worker motivation because health care delivery is highly labor intensive. Motivation determinants originate at many levels: the individual, the organizational context and the cultural context.

Individually, worker motivation is driven by individual technical capacity and resources/tools available to carry out the task, which determines the worker performance. From organizational aspect, motivation is influenced by organizational structures, resources, processes, culture and organizational feedback about performance. From cultural aspect, society and client feedback on health worker performance influences the motivation.

Regarding feedback, which is the subject of this master thesis, followings are the relevant key points: 1) Try to extend authority for providing feedback to agents situated closer to the health worker. e.g. decentralization of human resource decision to local unit; encouragement of hospital boards, district health boards, and health center committees to place more authority for providing feedback in the hands of local communities; 2) Supervision and performance assessment processes should provide corrective feedback and encouragement to workers; 3) Recognition of cultural characteristics of different environments may help frame an approach that is better suited to health worker values, and hence is more likely to improve worker motivation (beyond financial incentive).

In their research, Mathauer and Imhoff [16] studied non-financial incentives impacts to health worker motivation in Benin and Kenya from interviews and group

discussions. The study showed that health workers overall are strongly guided by their professional conscience and similar aspects related to professional ethos. In fact, many health workers are demotivated and frustrated precisely because they are unable to satisfy their professional conscience and impeded in pursuing their vocation due to lack of means and supplies and due to inadequate or inappropriately applied human resources management (HRM) tools. The study also indicates that even some HRM tools that are applied may adversely affect the motivation of health workers.

The study also highlighted, by reference to Zimbabwe, that health workers based in remote areas, despite lack of financial incentives and hard working conditions, frequently exhibited a high level of motivation due to good leadership and supportive management. However it was mentioned that supervision could lead two contradictory impacts: 1) supervision as control mechanism, which causes negative effect to worker made feeling under a monitoring/surveillance; 2) supervision as a mechanism for support/guidance to do the job and recognition for the effort.

It also suggested that feedback is required but it must not only focus on shortcomings or technical aspects of service provision. But it also has to focus on the personal perspective of the health worker. In terms of appreciation, it was revealed that client/patient/community appreciation motivates health workers more than supervisor appreciation.

Another study by Rowe [17] presented an overview of issues and evidence about the determinants of health workers performance and strategies for improving it. The study suggested that a simple dissemination of written guidelines is often ineffective, whereas supervision and audit with feedback is generally effective. He also suggested that multifaceted interventions might be more effective than single intervention.

What appears to be relevant to this master thesis from this study are: 1) based on cognitive theory, undesirable behaviors are caused by a lack of information, and it can be improved by disseminating information on evidence-based guidelines; 2) based on behavioral and learning theories, behaviors are a result of external stimuli, and it can be improved by providing audit and feedback, reminders, modelling correct performance, incentives, sanctions, removing factors that are demoralizing; 3) a health management information system that includes indicators on quality of health-worker performance, routine supervision, and special surveys could help in establishing a quality improvement process.

#### 2.4.2. Information Culture



As mentioned in the importance of feedback, information culture plays vital role and at the same time has dependency to feedback. The relationship between feedback and information culture are bi-directional. A good and working feedback mechanism will nurture information culture, by creating awareness to health communities that the data they submit is really used and not go wasted. In this direction, it will create good incentive for health worker in continuing to collect data in quality and timely manner. They will know that submitting bad quality data or non-timely report will hit them back i.e. getting rubbish and useless feedback information based on low quality or too old data.

In the other direction, once health communities get used to getting feedback regularly, it will create information demand among them. They will request and be hungry for information that may help them in delivering the health service better, such as getting new knowledge or knowing how they perform against target or peers. In other word, the communities becomes “addicted” to information in positive way, demanding as much as information as they need.

However, culture building takes time. As described by Lippeveld [18], the first challenge is to convince decision-makers at central as well as at peripheral levels that quality information really can help them to make informed decisions for patients and clients, health units, and health system management. This requires a reform, a complex organizational intervention, that needs a carefully managed change process.

The main issue is that information systems are managed and used by people who may have different beliefs, attitudes and practices. For example, care providers feel threatened by a system that leads to objective decision making and are suspicious of automation; health care consumers feel that more accessible information systems are threats to confidentiality; and there could be lack of mutual understanding between data people and action people. It is yet to mention in the context of government bureaucracies in developing countries.

Producing and utilizing information more effectively will affect the behavior and motivation of all parties. Therefore it is important to have a full understanding of what is at stake for each parties involved in the changes. Different party may have different interest and expectation.

The crucial things to nurture information culture is leadership and consensus building. Strong leadership is required to manage the resistance. As for consensus building, it is

clearly important that active participation of key actors will foster mutual understanding to provide ultimate support.

## **2.5. Designing new functionality over existing infrastructure**

Uganda has been using DHIS2 as the backbone of their health information system. Aligned with that direction, WEMR as a program under Ministry of Health also uses DHIS2. However, we need to note that DHIS2 is not the only system within the country's health information infrastructure. DHIS2 as system is interconnected with other systems such as SMS gateway system, patient recording system, logistic system etc. Specifically, DHIS2 system at WEMR as our test bed is connected to mTrac system (more detail on mTrac and DHIS2 WEMR will be elaborated in chapter four).

In such interconnected infrastructure, adding new element or functionality in one system within the infrastructure may have some implication to other system. In addition, to make the new element or new functionality works, it require certain support from existing functionalities, existing processes and existing users from the modified system or from the interconnected system. Therefore the strategy to add new element or functionality over existing WEMR DHIS2 system plays important role in the success of the project. In this section, we learn several points from literature about the strategy to design new element over existing interconnected systems.

### **2.5.1. DHIS2 as evolving infrastructure**

DHIS2 at the lowest level contains a collection of software artifacts. That collection of software artifacts builds an application system. Furthermore, when the application system provides data and services as resource for others, that application system can be seen as infrastructure. That is similar to how physical infrastructure such as road, port, cables provide resources for other services to run as the underlying substructures/foundations. Likewise, DHIS2 is providing/getting data and services to human actor (users or organizations) and to other systems (e.g. mTrac, patient recording system etc.).

Hanseth [52] suggested that one key characteristic of infrastructure is evolving. This is rather different from the classical view of software development, which focuses on single software artifact within a given time frame with well predefined specifications. As infrastructure, it is evolving over time when new functionality, new application or new information is added. The existing or the available

infrastructure within a given context in which we add something new is referred as *installed base*. An installed based may consist of hardware, software, information or knowledge with human or non-human actors interacting with it.

Such evolution implies that we need to be careful when designing new functionality upon an installed base. One isolated software artifact may be easy to change, but when it is integrated to many others there will be many dependencies that may break when new functionality added, or perhaps the new functionality will not work/usable. As Aanestad [53] argued, human ability to create complex system may outrun the ability to govern them. Without careful governance and approach, the evolution may go out of control and even bring down the infrastructure itself. The installed base theory advises that the available infrastructure limits and influences the design process in adding new software artifact, which will bring us to bootstrapping and cultivation discussion in next sections. These approaches become relevant to this project as we add new SMS feedback functionality to existing working WEMR system as our installed base.

#### 2.5.2. Bootstrapping and cultivation

Bootstrapping is described by Hanseth and Aanestad [54] as the process of making a tool by means of the existing tool itself. It starts with the first simple tool being developed, where getting first users would be the challenge. Subsequently, we draw upon existing base of users and tools in order to extend it further. It is an opposite of big bang approach which suggests us to have well predefined requirements or standards to anticipate all expected functionalities before developing the complete system in full scale. The motivation behind bootstrapping approach is based on past experiences whereby big bang design approach for a complex systems or infrastructures involving big number of parties may not take off, due to difficulty in getting consensus and anticipation of complete future functionalities. Therefore, it makes sense to start with something simple but useful, and then subsequently adapt and expand it for new functionalities.

In this approach, Hanseth and Lyttinen suggest five principles which can be followed. Three of them addressing bootstrap or starting-up problems and the other two addressing adaptability or expandability problems.

The first principle is “design initially for direct usefulness”, which means we need to start with small group, simple to use/implement and offer direct/immediate benefit. We understand that the challenge in starting up a new tool or functionality is to get the first group of users. Without first users, the tool will be simply unusable and will not take off. Hence it is very important to attract the first users, whereby direct usefulness is a key appealing point for them to adopt. If they feel it is useful, they will become supporter. Consequently, to understand the expected usefulness, we will need to identify small population of first users and really understand their essential problems and needs. In addition, first users are typically exposed to high adoption costs and risks, compared to late adopters. We cannot expect initial high investment. Hence designing a cheap and simple-to-use solution is advocated to mitigate that costs and risks. We know that the solution may not be satisfying broad group of different users, but at least we will get positive feedback from first users whom will enable the tool to take off further.

Second principle is “build on installed bases”, which means we need to utilize existing installed base as much as possible. Here the principle suggests the design to not depend on new support infrastructure, rather to rely on existing ones. We understand that new support infrastructure typically will increase the implementation costs, risks and barriers. When we already have existing infrastructure, the new design is better to be built on top of it. In case the new design does not really compatible with existing infrastructure, we can work it out by establishing a gateway to facilitate communication with existing ones. Hence, the idea here is to keep installed base as pivotal point in the design process.

The third principle is “expand installed base with persuasive enrollment tactics to gain momentum”, which means after establishing first usefulness, we need to sustain growth by persuading more user base to participate. One rule within this principle is to put users before functionality, that means designer cannot push new functionality blindly and ask users to adopt, but rather let users to use the existing system and they will come up with new needs that will become new functionality requirement for the designer. This implies that new functionality is developed and system is enhanced as and when needed. One key point here is that growing user communities plays important role in the expansion/enhancement process.

The fourth principle is “to make the organization of IT capabilities simple”. Here, we need to make the capabilities as simple as possible both in terms of technical and social complexity. The simpler the solution, the easier it is to be adopted and enhanced. This principle is closely related to the last/fifth principle to “modularize information infrastructure” for more adaptability. This principle suggests us to decompose complex infrastructure into more modular layers which are loosely coupled. In between the layers, we can specify gateway to enable communication. Such gateway approach can be used to facilitate backward and forward compatibility for same layers but in different versions. The main purpose of this modularization is to make it easier in enhancing certain parts of the capabilities without impacting the other parts too much.

In summary, the above bootstrapping principles describes an evolution process where we need to build something small first; deploy for small users group; expand the users adoption which triggers new needs; build the new capabilities to address the new needs on top of existing installed bases; and while building new capabilities, we make them modular and organize them as simple as possible. From evolution point of view, Hanseth describes the installed base as *“a sort of a living organism that can be cultivated, instead of dead material to be designed”*. This brings us to cultivation terminology which has several characteristics. First, it is an on-going process, so it is not a single event with certain end point as steady state. Second, during that on-going process we cannot anticipate all various technological and organizational changes ahead of time. Within cultivation view, we reckon that there is certain limit of rational/human control, due to the fact that there are various actors involved such as designer, product manufacturer, service provider, users as well as the installed base itself. This is as opposed to classic design view, which implies that we can set certain fixed specifications ahead of time as control measure.

As this project is based on existing Uganda WEMR infrastructure, the bootstrapping and cultivation view become relevant as suitable approach. We will discuss that in analysis and discussion chapters.

### **3. Methodology**

This thesis is mainly based on qualitative research approach. In particular, it follows interpretive paradigm. The interpretive paradigm is described by Walsham [19] as "aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context", which is suitable for this thesis research questions. Because this research is looking at the impact of sending SMS feedback to health workers from health workers perspective.

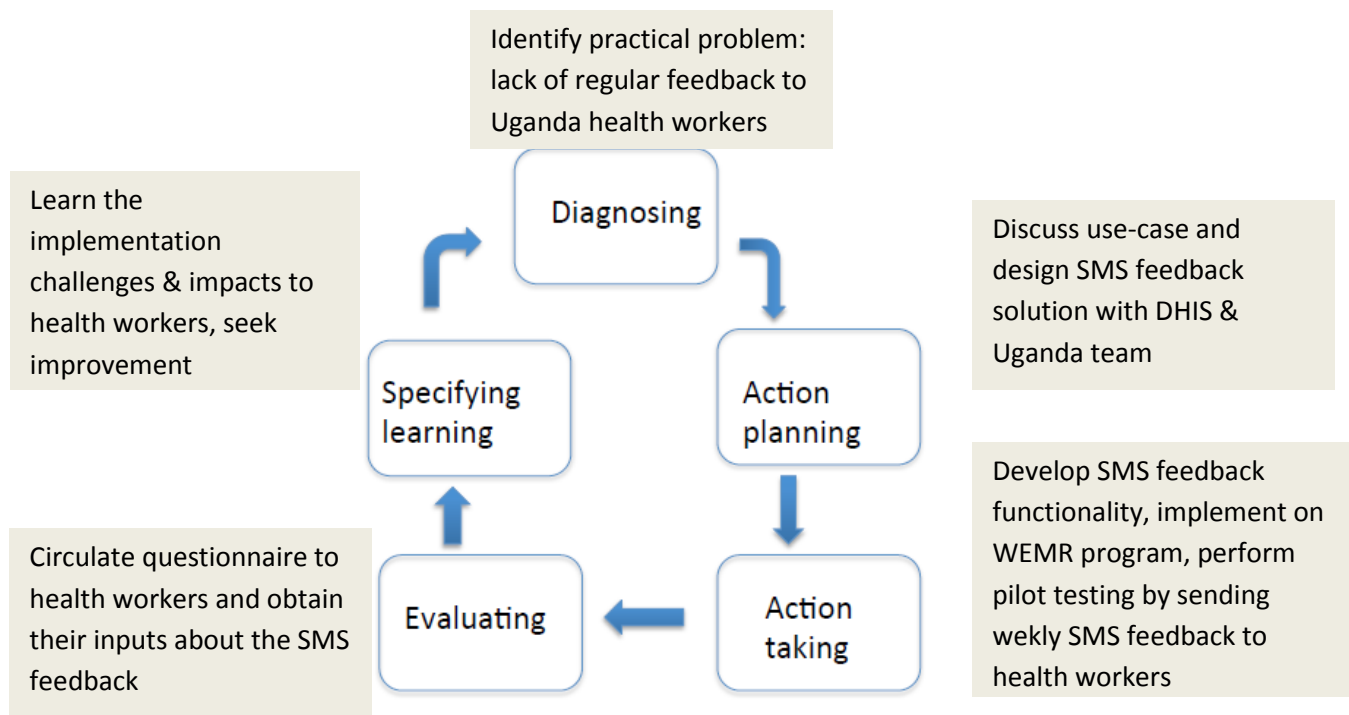
From methodology perspective, the thesis follows combination between action research and case study. The introduction of action research and case study will be elaborated below, as well as how they fit and apply to the thesis.

The methods used to collect the data are questionnaire/interview, document analysis, Internet research and discussion through email/Skype. The document analysis is performed from previous relevant/similar implementations in other locations, Uganda specific documents and field notes from colleague whom travelled to the site.

#### **3.1. Action Research**

Action research is a research methodology that aims to solve practical problem but at the same time tries contributing to theory building through a collaboration [20]. As a result, the researcher may play practitioner role as well when solving the practical problem. This fits well in information system field because we need to understand the complexity of the system in reality, and that would require certain degree of practicality rather than just theoretical.

Action research is an iterative process. It starts with diagnosing, where we identify the problems. Then action planning, where we plan actions to solve the problems. It is followed by action taking, which is the execution. Evaluation is performed to measure the actual result against the expectation. Lastly, we specify the learning points from the cycle, before starting new iteration if the problem is still not solved.



*Figure 5. Application of action research to this thesis*

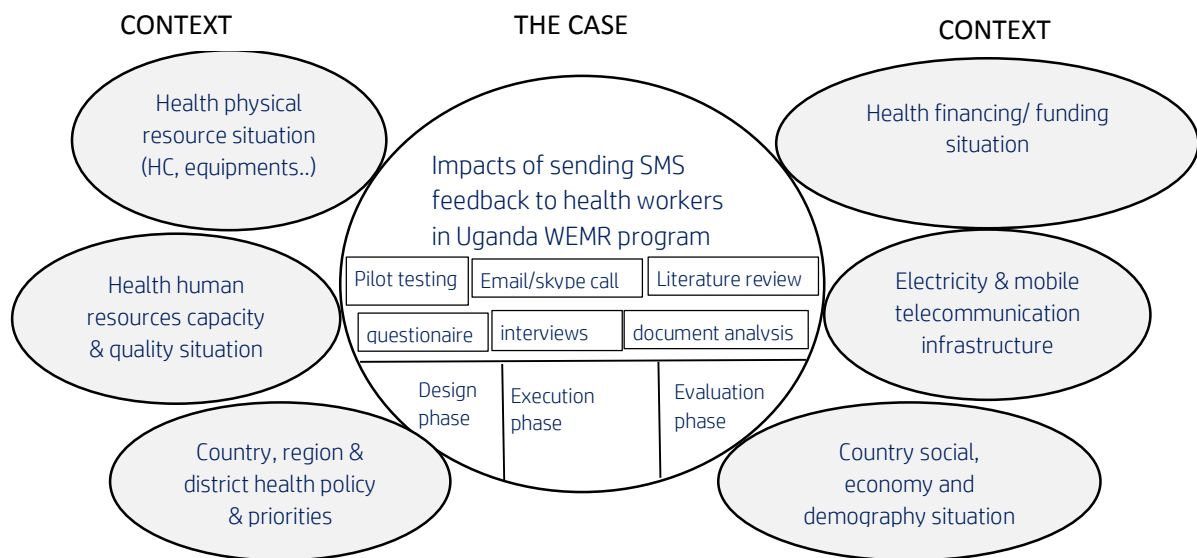
However, there is critic due to the blurring segregation between researcher and practitioner role [20]. If the research does not have clear research questions and does not follow the appropriate methodology, it may end up as a consultancy project rather than academic research. Other aspect that may differentiate between the two is that consultancy project typically intends to please the client (i.e. the research participants). Whereas action research should have certain vision on how the reality should be, not necessarily always pleasing the participants. There should be element of critical distance to avoid bias or subjectivity although the researcher has been immersed with participants for considerable duration. That critical distance would open up the ability to discover important issue from outsider point of view.

Another challenge is that how the conclusion drawn from the action research can contribute in theory building. This implies the research result needs to be reproducible in order to be useful to others. One issue is to what extent the similarity of the setting will allow the reproducibility of the result and therefore making it eligible to become a part of theory. For example, action research in this project is to see the impact of sending SMS feedback to health worker in Uganda. The result may be influenced by social culture, health worker workload, demography etc. that is bound to Uganda's setting. The same result may not be reproducible when applied in different countries with some setting variations e.g. different social culture.

This thesis is built on the basis of DHIS as application, which is developed under HISP program. HISP program itself is a network of action which follows participatory approach. That participatory approach is essentially part of action research methodology domain. The problem formulation and design of the software artifact was based on input from and discussion with a group of people that consists of users in Uganda and master students as researchers, guided by students' supervisor.

### 3.2. Case Study

Case study is a study of phenomena in their context, as suggested by Baxter [21]. It involves in-depth examination of instance, event or example. That instance is referred as a case, whereby it needs to be specific, unique and bounded. The boundary is the context, which can be: social, cultural, economic, legal, political or historical context. A case study is a situated and detailed inquiry for learning and not necessarily for proving, as suggested by Flyvbjerg [22]. Stake [23] added that it focuses on activities, functions and local meaning within specific case.



*Figure 6. Application of case study to this thesis*

Case study can be intrinsic, instrumental or collective. In intrinsic case study the research goal is to understand the case itself. In instrumental case study the research goal is not to understand the case itself but rather other issue, whereby the case is just an instrument to obtain knowledge on more general level. Collective case study is used whenever there are multiple interrelated case studies required to investigate a common phenomenon. So collective case study could be seen as collection of several instrumental case studies.



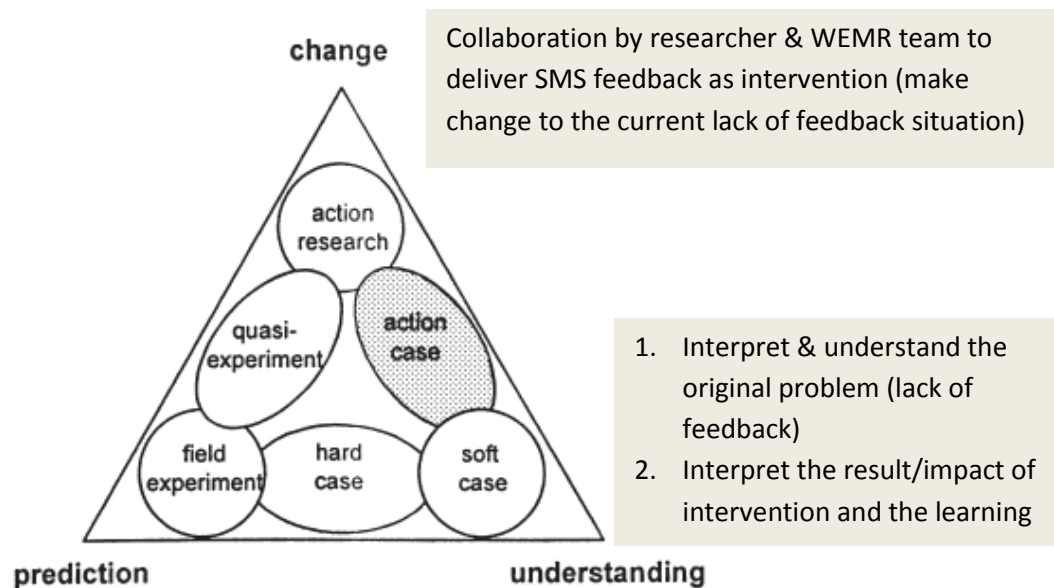
This master thesis is an intrinsic case study, and finding out the impact of sending SMS feedback to Uganda WEMR health worker is the boundary of the case. The result of the study may or may not necessarily be valid for broader context outside Uganda WEMR program, or in other word it may or may not be generalizable. Outside the case boundary there are various context, which may influence the case study results, such as:

- Health physical resource situation (health center, equipments etc.)
- Health human resources capacity & quality situation
- Country, region & district health policy & priorities
- Health financing/ funding situation
- Electricity & mobile telecommunication infrastructure
- Country social, economy and demography situation

### **3.3. Action case**

As this thesis can be seen as a combination between action research and case study, arguably it can be considered as an '*action case*' type of methodology. While the action research aspect of this thesis refers to the collaboration activities between researcher and participants in delivering the SMS feedback intervention to make change, the case study aspect is interpreting/understanding the impact and learning as the result of intervention. The interpretation is also used in diagnosing and understanding the problem in early phase based on preliminary interviews with health workers, which will be translated into use case and provides baseline to the intervention.

Braa and Vidgen [47] described action case as hybrid of interpretation and intervention. The pure approaches of in-context research can be drawn as a triangle. The extreme points of the triangle are aiming at either prediction (positivist type of field experiment), changing (action research) or understanding (soft case study). In between those extreme points, there are middle points which tradeoffs each other. In this thesis context, where action research and case study are used, the middle point is called action case. Here the tradeoff is that while trying to understand the case, we as researcher actually participate in making change to the case by doing intervention. This action case is valid approach to this thesis considering that the intervention is performed at a small scale (pilot to 10 health facilities within 2-3 months period) and the use case is very much tailored to WEMR specific requirement.



*Figure 7. Application of action case to this thesis*

### **3.4. Data Collection Methods**

This thesis employs several methods in gathering and analyzing the data.

#### **Interview and questionnaire**

Although the author did not personally visit Uganda, there were several interview questions which were passed on to fellow student who visited the field site, prior to the SMS feedback testing period. The interview questions are mainly to understand the current reporting and feedback process, as well as to get health workers' difficulty and aspiration on information they need. The questions were then combined with the fellow student's list of questions and used for semi structured interviews. The interviews were conducted at health workers' workplace/facility. The interviewees were from different profession background including nurse, midwife, IT support, health counsellor and WEMR coordinator. The interview results were then analyzed together with other field notes. These pre-testing interview results were used to help determining the appropriate SMS messages content for pilot testing.

After the pilot testing period, another questionnaire was performed to understand the impact of SMS feedback intervention. The questionnaire was circulated to health workers who represented all nine facilities that participated in the SMS feedback testing. This post-testing questionnaire result was analyzed and used as basis for answering the main research questions and concluding the research itself. More detail on the post-testing

questionnaire and the result are available in chapter five (findings) and chapter six (discussion).

### Document analysis

There are various documents made available from Uganda, both specific to WEMR program and more generic on its health system and health information system. The purpose of this document analysis is to understand how Uganda health system is structured, how Uganda current health situations are (beyond what was observed during field trip) and how WEMR program is planned, organized and run. Other than that, data from WEMR DHIS2 server is also analyzed to get better understanding on what kind of data that we can use for SMS feedback. Other importance source of data is field notes which was shared by fellow student who visited the site. All those document analysis helps us in: understanding context of our project, formulating what we can do for SMS feedback and making sense the SMS feedback test result. Majority of this document analysis is presented in chapter four (background and empirical setting).

### Internet research

Some documents/information are also obtained from Uganda official government bodies websites, such as country health profile, demography and various official health reports. They serve as secondary data, complementing primary data obtained directly from the field. There are also some data obtained from Internet pertaining similar studies in other locations/countries on SMS intervention within mHealth solution which we use as part of literature review. The purpose of this Internet research is to understand what SMS-based solutions have been implemented by others, which we can learn from, and we can identify the similarities as well as the differences. Much of information from this Internet research is presented in chapter two (literature review), chapter four (background and empirical setting) and chapter five (findings).

### Discussion via electronic communication

During the development of SMS feedback capability, electronic communication was frequently used in discussion. Emails were employed to exchange information with fellow student working on same topic while he was on site, and also with DHIS2 mobile

development team in Vietnam as well as with users in Uganda. Skype calls and Skype chats were also heavily used to communicate.

The purpose of those discussions are: to get input from DHIS2 mobile development team in understanding the existing DHIS2 capability and determine what enhancement possible based on the architecture; to get input from WEMR team on the requirements, determine the possible solution, address the issues and next actions to implement the solution.

Statistically, during this project we have been exchanging more than fifteen emails with DHIS2 mobile development team in Vietnam/Oslo, more than thirty emails with Uganda WEMR team, around five Skype calls with DHIS2 mobile development team and around fifteen Skype calls and/or Skype chat sessions with Uganda WEMR team. Since the related parties are located in different parts of the world, such electronic communications were very much beneficial. Majority of the discussion points are presented in chapter five (findings) which covers SMS feedback development process, pilot testing planning & execution, as well as result analysis from the pilot testing.

## 4. Background and Empirical Setting

### 4.1. Uganda Demography and Health Situation

#### Demography

Uganda is a land locked country, located in East-Central Africa, west of Kenya, east of the Democratic Republic of the Congo. It is a tropical country, whose terrains are mostly plateau with rim of mountains. It has around 35.92 millions of population [24], with population density of around 174/square km [25]. Administratively it consists of 112 district, 181 counties, 1382 sub counties [25]. The districts can be classified into 4 areas: central, eastern, northern and western.

#### Health Situation

Historically, in 1986 the health sector was in near collapse state with poorly equipped public health facilities and demoralized health workers due to very low and irregular wages. The breakdown was worsened by re-emergence of previously controlled diseases (such as sleeping sickness, TB, guinea worm, measles) and emergence of new disease HIV/AIDS. Since then Uganda embarked on major reforms, focusing on rehabilitation of existing facilities to restore functional capacity and emphasizing to Primary Health Care with a defined Minimum Package of cost-effective services [26].

In early 1990's, Uganda embraced Decentralization as part of Public Sector Reform, whereby the central government mandate policy formulation and local governments mandate was to implement the policies and mobilize local resources. The economic and other social indicators began to rise and all contributed to improvement in health status.

However, despite of the continual progress, the health status of Uganda is still relatively poor. Some key health indicators in 2011 are shown below:

- Infant-mortality-rate is 61 death/1000 live birth, number 21 in the world.
- Maternal-mortality-rate 310 death/100,000 live birth, number 37 in the world.
- Fertility rate is 6 children/woman, number 5 in the world.
- HIV-prevalence-rate is 7.2%, no 10 in the world.
- People living with HIV is 1.5 millions, no 6 in the world.
- Physician ratio as low as 0.12 / 1000 population.
- Life expectancy is 54.46 year.

- Population age distribution 49% between 0-14 years.

The above key indicators suggest that there are still big rooms available for improvements.

#### 4.2. Uganda Health System

##### 4.2.1. Policy

In 1999/2000, a ten-year National Health Policy (NHP) was launched by Uganda government and followed by a five-year Health Sector Strategic Plan (HSSP) to enhance public health status via several approaches as elaborated below [26]:

- A minimum packaged of service (Uganda National Minimum Health Care Package/UNMHCP) was articulated to determine the allocation of funds.
- Realignment of structure and role/responsibility between central and local government, in line with 1995 constitution and local government act 1997. The central will provide policy stewardship, the District Health Service delivers the UNMHCP in integrated manner.
- Health Financing Strategy (HFS) and Sector Wide Approach (SWAp) were introduced to promote equitable allocation of resource and stronger donor coordination.
- Empowering communities to take responsibility for their own health and participate actively in local health service management.
- Enacting public-private partnership for health policy

##### 4.2.2. Components of Uganda Health System

###### Public Sector

Lippeveld [13] described typical health system as organization of several concentration levels, from the primary level up to tertiary level. Each level has different functions. For example, primary level is the first point of contact to the population in delivering health service. Secondary and tertiary levels provide referral service with more specialized/advance interventions. While primary level is more operational in nature, secondary and tertiary levels perform more strategic planning and management control/decision making.

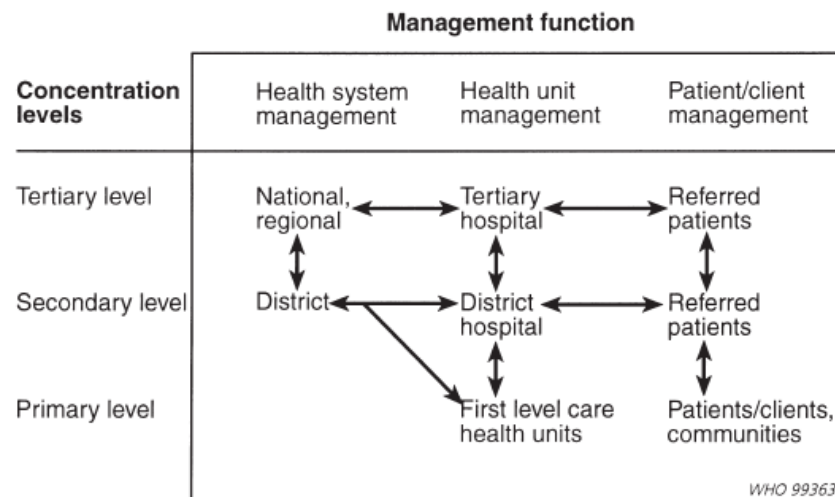


Figure 8. Organizational model of health services (Lippeveld [13])

Similarly, Uganda public health care system consists of tiered structured of health facilities. At the highest level, there are national referral hospitals, currently they are Mulago hospital and Butabika hospital. One level lower, there are several semi-autonomous regional referral hospitals. Then, in every district there are district hospitals under the leadership of District Directorate of Health Service.

With the decentralization approach, multiple Health Sub-District (HSD) health centers were established, with the designation to deliver UNMHCP to the community via the following hierarchy of health facility levels:

- Health Centre I (HC I) - a satellite health facility with no definite physical structure. It is where health facility out-reach teams meet the community for EPI, Health Education activities etc. It is also referred as Village Health Team/VHT or Community Health Worker/CHW.
- HC II- the closest structural Health facility to the community. It delivers the MAP (Minimum Activity Package of the UNMHCP). This HC II may not have doctor.
- HC III- The facility that delivers the Intermediate Referral Activity Package (IRAP) of the UNMHCP. It handles referrals from the HC II as well as referring to HC IV. By level, it equates the sub-county level of the Local Government administration. This HC III has doctors.
- HC IV- Is a mini hospital and delivers the CAP (Complimentary Activity Package). This HC IV has general practitioner doctors and may have specialist clinic.

Uganda health center I, II and III can be considered as primary level in Lippeveld model, whereas health center IV at district level plays secondary level role. The regional and national hospitals serve as tertiary level.

#### Private Sector

Private sector contributes to 32% of Uganda health facility provision (as of 2004, reported in Uganda Health System Profile 2005) and is rapidly growing. Therefore it is worthy to be noted. Uganda private sector consists of:

- Facility based Private Not For profit (PNFP). The facility-based PNFP have a large infrastructure base comprising of a network of hospitals and health centres.
- Non-facility based Private Not For profit (PNFP). It comprises of various local and international Non Government Organization/NGO, which operates on other party's owned facilities.
- Private for profit (PFP). It consists of licensed medical practitioners who provide typically primary level services.

#### 4.2.3. Physical resources situation

Physical resources comprise of health infrastructures/facilities, health equipments and medicine/medical supplies. As mentioned earlier, the infrastructure consists of multi-tiered facilities from hospital (national referral, regional referral and district) to Health Center (HC IV, HC III and HC II). As per MoH report in 2010, there have been 2655 government, 801 private non-profit and 994 private for profit facilities. In terms of equipment there is still low adequacy, for example in 2010 the hospital bed is just 0.5 /1000 population [24]. This describes how over- stretched its physical resources compared to the number of patient.

#### 4.2.4. Human resources

Uganda is still experiencing a shortage of trained workforce. Report in 2010 indicated there was a very low doctor to patient ratio of 1:24,725 and a nurse to patient ratio of 1:11,000 [27]. About 25% of the doctors registered with the medical council are foreigners and the MoH has no guarantee of how long they can stay in the country [26]. Several challenges perceived in getting the gap closed are limited funding for recruitment, lengthy recruitment processes, low



training outputs and poor retention due to poor motivational factors (such as low wage) [28].

The over stretched and overburdened of physical resources and human resources create a degrading implication to the health service quality and performance. Patients lining up for hours is not uncommon, even in Mulago national hospital as the biggest health facility. Nurses are very busy that reporting sometimes needs to be done after work from home, which was known based on interview with some them.

#### 4.2.5. Health financing situation

In MoH 2010 report, it was indicated that the financing source are mainly from households (50%), donors (35%) and government (15%). Despite of the abolishment of user-fee in 2001, households still appear to be necessitated to allocate significant expenditure for health medication, mainly (35%) for basic treatment [28]. On the other side, donors have been encouraged to channel the funding through Central Budget Support to ensure that the spending is aligned with MoH priorities.

#### 4.2.6. DHIS2 and HISP in Uganda

This section will elaborate DHIS2 and HISP presence in Uganda, which provides test bed/laboratory for this master thesis project.

##### DHIS2

DHIS2 (District Health Information System) is open source web based health information system built as successor of MS Access based DHIS software. There are distributed developers around the world who build DHIS2, however the main development site is located in University of Oslo. DHIS2 was originally developed for South Africa in the beginning, but now it has been used in 47 countries in Africa, Asia and America. At present it has been rolled out as national HIS in 16 countries.

With the decentralization health policy being applied in Uganda, where district level has mandate to deliver UNMHCP service, DHIS2 is very much aligned to the policy. Uganda is the third African country which rolled out DHIS2 as national system in 2012, after Kenya and Ghana. The preparation was started in August 2010 when CDC Uganda initiated a contact with University of Oslo and followed by Uganda team attendance at DHIS2 academy in Dar es Salaam

in 2011. That forum facilitated knowledge sharing by Kenya team whom was in the midst of Kenya national DHIS2 roll out. Uganda training session was started in 2012 for Saving Mother Giving Life pilot districts and followed by initiation of national roll out in June 2012. The national rollout completed in August 2012 [33]. Since then, Ugandan team has been actively participated in DHIS2 further development, including development of module to track women antenatal, delivery and postnatal care.

At present there are several DHIS2 installations in Uganda. Some notable installations are:

- The national HIS instance at domain “hmis2.health.go.ug”, which is operated by MoH
- eMTCT SMS reporting instance at domain “dhis2sms.ug”, which is used for prevention of HIV/AIDS from mother to child with Option B+ program. At present, the Option B+ program has covered more than 1700 actively reporting facilities. In its operation, the program is working closely with both META team (Monitoring and Evaluation Technical Assistance) and CDC (Center for Disease Control).
- Web-based Electronic Medical Record (WEMR) system at domain “wemr.ug”, which is used for mother and child antenatal, delivery and postnatal care.

As DHIS2 has been officially appointed as national health information system, it is also connected to several other Uganda eHealth systems. One notable system is mTrac. mTrac is a government led initiative to digitize the transfer of Health Management Information System (HMIS) data via mobile phones. The initial focus of mTrac is to speed up the transfer of HMIS Weekly Surveillance Reports (covering disease outbreaks and medicines), to provide a mechanism for community members to report on service delivery challenges, and to empower District Health Teams by providing timely information for action. All mTrac data is automatically fed into the national DHIS2 database. mTrac uses free and open-source software called RapidSMS, which has been deployed in over 20 countries. The eMTCT and WEMR DHIS2 instances are presently connected to mTrac and use it as SMS gateway under common number 6767.

## HISP

DHIS2 is developed under an umbrella organization called HISP (Health Information Systems Programme). HISP itself is a global action network, which was originally founded in South Africa in 1994 post-apartheid era [29]. Currently, HISP as a network has presence in several countries/regions; some notable network nodes namely: HISP Vietnam, HISP Kenya, HISP India, HISP Uganda, HISP Rwanda, HISP Nigeria, HISP East Africa and HISP West Africa. The global network of HISP is now coordinated by the Department of Informatics at University of Oslo (UiO). As the coordinator, HISP UiO main goal is “to enable and support countries to strengthen their health systems and their capacity to govern their Health Information Systems in a sustainable way to improve the management and delivery of health services”. Being the umbrella of DHIS2 development, HISP is jointly funded by Norad, The Global Fund and PEPFAR [30].

Other than developing and implementing DHIS2 as a software system, HISP also holds regular DHIS2 academy. DHIS2 academy is capacity building initiative aiming to strengthen national and regional capacity to successfully set up, design and maintain DHIS2 systems [51]. It is conducted at various regions around the world including East Africa (where Uganda is located). It provides intensive trainings at multiple expertise levels, from level 1 (fundamentals), level 2 (intermediate), level 3 (advanced) and expert. The academy addresses capacity building from technical perspective, best practices as well as health information management aspects.

HISP Uganda is one of the newly established network node, which is officially located in the capital city of Kampala. HISP Uganda has philosophy of “a collaborative south-south and south-north network aiming to improve health care in developing countries through research and implementation of Health Information Systems” [31]. Although as organization it was founded just recently, the HISP Uganda staffs have been very much affluent with DHIS2 since Uganda’s DHIS2 national implementation in 2012. The team has been actively involved in development of new module for maternal and child health tracking, as well as development of mobile reporting.

Today, HISP Uganda has been a key partner in hosting DHIS2 academies in East Africa region and the staffs have been frequently invited as key presenters

in the academies. In terms of service offering, HISP Uganda provides several DHIS2 trainings, such as customization, data entry, data reporting and visualization as well as server management [31]. In its various projects, HISP Uganda presently works closely with HISP Rwanda and Mackerere University-John Hopkins University (MUJHU).

#### 4.2.7. Web Electronic Medical Record (WEMR)

WEMR is a pilot program which aims to evaluate the effectiveness of the targeted SMS to mother and child antenatal, delivery and postnatal continuum of care, by increasing the number of visit. The program is facilitated by MUJHU. It was initiated back in 2013 and at present is in pilot phase in two districts (Kampala and Mpigi, with five to six facilities in each district). The background of the project is due to low number of delivery in health center (41%) and postnatal attendance (38%), despite of high number of ANC coverage with 94% attending at least one ANC visit [32]. Poor postnatal attendance compromises the delivery of MNCH and PMTCT services, which is more risky for HIV-infected women and their HIV-exposed infants.

WEMR is built as part of DHIS2 tracker module. As background, DHIS2 tracker module (also known as DHIS Community Module) is developed to support community health systems and facilitate a smooth integration between the community health data and aggregated data management [52]. While we know that DHIS2 covers aggregated information by data entry, this module offers capability to track individual patient so that we can understand the quality of health service provided to a patient. Tracker will allow us to monitor patient status and remind the patient if certain intervention is needed. Such individual tracking records subsequently can be aggregated by DHIS2 system automatically at regular period (e.g. weekly, monthly etc.) to the higher levels (e.g. facilities, district, province etc.) based on certain rules.

The WEMR system itself consists of two components. The first one is web-based MNCH/PMTCT EMR system to capture and store patient data across facilities. This part of the solution is intended to overcome two practical issues. The first issue is patient data availability, whereby previously registration/patient data capture is performed in a book and making it difficult to find the patient data after several months of gap between the visits. Other issue is when the book supply is

not available, the health worker may record patient data in somewhere else which leads to data loss. With WEMR, it is much easier and quicker to find patient data.

The second issue is related to patient mobility. The patient may register for the first visit in one facility, but may not go to the same facility for the next visits, but rather going to different facility. The absence of patient's previous data in the new facility may reduce the quality of health service, and also create redundancy in patient registration data across facilities. As a result, the majority of women and their infants are 'lost' to their original facility tracking soon after delivery because they either do not return for scheduled follow-up visits or they are accessing care at another health care facility. With WEMR, once patient data registered in one facility, it is also accessible from other facility; hence, making it easier for the health worker to find the patient historical data record and providing more appropriate care based on that data.

The second component of WEMR is the targeted SMS to the patient. It is often that the visiting woman does not come back for the next visit. With WEMR, every visit is scheduled in the system. When visit appointment is about to due, an SMS reminder will be sent to the patient two days in advance. If the patient still does not come after the appointed date, another SMS reminder will be sent, 1 day and 7 days after the scheduled appointment. The objective of this targeted SMS is to increase the reattendance.

At present, the pilot has been going well, despite of some technical issues with DHIS2 systems. For example, sending an SMS reminder that is not in the right time, such as notifying patients that they have missed appointments even before the appointments have taken place; or the SMS reminder that is not sent in time, causing a patient does not come on the appointment date. Other challenge is the language because not all patients understand English but rather Ugandan local language.

Also, as in other developing countries, the program faces unstable power supply and good Internet connection in the health facilities, that makes health workers sometimes need to work and submit the report from home. In this circumstances, using mobile phone for reporting is felt more dependable by the health worker as it does not depend so much on power supply and have more reliable mobile

network than Internet. In addition, a health worker mentioned that mobile reporting is simpler and easier to use than computer based reporting.

Computer literacy among health workers is another challenge. Many of the nurse or mid wife are not familiar with computer, and therefore, an IT person sometimes is required to help them using the system. When a patient comes, she will get a card where her detail will be captured and she will be given a patient number if she is new. After the patient has got the medical examination, the examination paper will be passed on to a health worker, or in some cases to IT intern, who will register the information to WEMR system.

#### 4.2.8. Current feedback mechanism to health worker

At present, there has been various feedback mechanism to health worker, despite the irregularity and uncertainty of the process. In Option B+, for example, health worker usually asks the statistician regarding reporting in ad-hoc basis. There is also weekly reporting app which is built on Android platform, that is used by PMTCT Option B+ program. However, at present, the Android app is used only by district officer and implementing partners, rather than the health worker at lowest level.

An officer at WEMR program mentioned that they expect the nurse or mid wife, or health workers in general, to perceive the importance of information they get from the feedback report. However, due to large number of patient, sometimes the health worker does not have time to submit report, not even to analyse the report, despite of health worker's interest in using the system

*“..from my point of view although these mid wives send data they do not really care much for it, to some it is just a task one has to do on a weekly basis, so I thought we are supposed to encourage information use by sending this automated feedback ..... they are able to use this information for many more things..”*

There is also aspiration from health worker to get feedback on the number of patients being expected to come for the day based on the scheduled appointment, so they can be prepared upfront. They feel it can increase their service level. Also, there are input from health workers that they would like to receive feedback on how they performed, what works and what does not work. In Option B+ program,

that kind of regular feedback through weekly meeting is actually planned. In that meeting, the team from MUJHU comes to the facility and presents how the facility is progressing. However, in practical, due to limited time and resource, the weekly meeting may not always happen. Such close feedback and supervision is felt important by the health workers, as they suggest that monitoring by phone or other telecommunication medium are not as good as getting personal feedback face to face. That is especially important to monitor their progress against the goals/targets which have been set by MoH, district or facility.

mTrac system has been used to send various feedback information to health worker. For example, outbreak information, salary related information, as well as how the facility is doing compared to others. The health workers feel that such information can boost the confidence, for example, knowing that the medicine will come so they can feel more relieved when doing the work. Though sometimes the information is not relevant to particular health worker, it is not seen as a big problem of getting irrelevant information.

One researcher from CDC Uganda whom is also involved in WEMR suggested that it would be good to send back indicators to health worker at the level they are reporting. The purpose is to cultivate sense of belonging of their own data and improve their performance based on that. However the information needs to be a computed value instead of just raw data to add more value to health worker, because health worker typically already knows the raw data they send to the system. This kind of regular indicator feedback to health worker is what has been missing today. Because the main problem on the ground is that usually people do not get the information that they need. Aside from health worker, the implementing partner may be interested to get the same progress feedback.

Other than what we observed ourselves with feedback mechanism in Uganda CDC Option B+ and WEMR programs, we also learned that other NGO actually has tried SMS feedback mechanism. Within recent inSCALE project by Malaria Consortium [46], there has been pilot on SMS feedback to Village Health Worker. As part of the project, VHT will get a phone with inSCALE software for data submission. Based on the submitted data, automated SMS will be sent to supervisor to flag any problem or strength identified in the data, which may alert the supervisor if the VHT needs a targeted supervision. Monthly motivational message will also be sent to VHT based on VHT performance data to identify weak

area that needs reminder or refresher training, with the intention to improve VHT performance and motivation. However what we do in our SMS feedback project is rather different from inSCALE project. First, while inSCALE involves relationship between health worker and his/her supervisor in the feedback process, our project does not have that. We purely sends indicator SMS feedback to the health worker whom is responsible for a facility. The health worker himself could be a supervisor. Second, inSCALE positioned the SMS as a targeted motivational message, which is more personalized depending on each individual VHT's need or weakness. Whereas in our project, the indicators are reflection of the facility performance as collective individuals performance, instead of certain individual performance. So in summary, while we use the same SMS as medium to convey the message, the purpose and context of the message are rather different and therefore it is interesting to see how our projects findings will be, which is discussed in the next section.



## 5. Findings

### 5.1. SMS feedback development

In this section, the development of SMS feedback will be elaborated in more detail. It covers the challenges, the considerations and the solution which is eventually taken.

#### 5.1.1. Development Challenges

##### Evolution of Requirement and Setting

At the beginning of this master thesis, the original setting was for Timor Leste. The use case and requirement was pretty much open, therefore, how the SMS feedback would work was purely based on our assumption as researchers without actual inputs from users on field. We discussed internally between two master students and supervisors. However after few months down the line, it was not very clear if the ministry of health of Timor Leste was still keen on pursuing the SMS feedback functionality and no further requirement formulation specific to Timor Leste anymore.

Subsequently we tried to come up with several generic use cases:

- a. Feedback after reporting and reporting reminder with intention to provide recognition to health worker and his supervisor. The feedback would contain calculated figure on reporting completeness and comparison to other report submitters or other organization unit. The encouragement feedback was expected to increase the reporting rate. However, at the later stage, we found out that DHIS2 does not have existing module that links between a report and the person who should submit it. As DHIS2 is not HR system, there is also no module that links between health worker and the supervisor to enable such automated recognition process as well. It was deemed to be complex to build such module as a part of SMS feedback functionality, so this use case was then not explored further.
- b. Aggregated report subscription with the intention to send indicators or data elements via SMS to interested subscriber. The concept was that a list of subscribe-able indicators or data elements will be available on portal, and the user can freely choose one that he/she is interested in getting regular update by SMS, depending on how frequent the user wants to have it e.g. weekly, monthly etc. This use case was deemed to be more feasible, because

most of underlying functionalities have been available in DHIS2, such as basic system scheduling, basic SMS sending functionality and analytic functionality to query certain data element or indicator. Therefore, this use case was then prioritized and became the main focus.

During DHIS2 community event in Oslo, Uganda representative was getting involved in the discussion and started to provide further input on the idea. The input was basically to allow a report (based on pivot table report) to be sent in an SMS format. The main objective was to cultivate information culture among health worker, creating environment that can trigger demand/need for information. The background behind that is because currently Uganda, with Option B+, has been getting good reporting rate by SMS. However there is no feedback down to health workers who originally send the report, creating just one way information traffic. Learning from past projects, Uganda team has been deeply involved in the development of new features in DHIS2 such as tracker, and therefore their affluence to DHIS2 would add more dimension to the shaping of SMS feedback requirement in more concrete manner. Since then, Uganda has been chosen as the setting of the project.

#### Prototype or Ready Bundled Product?

DHIS2 has been in relatively mature state. The development process is well controlled as a product, following certain process flow such as formal requirement definition, code review, inclusion to version release etc. We reckon that SMS feedback functionality would require some changes on server side to allow SMS scheduling, SMS sending and some persistence level to keep the SMS template and the schedule information itself. While the requirement of this SMS feedback is relatively open and dynamic, we anticipated that the code will frequently need changes based on what we would find out, and that may be challenging to match the maturity nature of DHIS2 as a product.

On the other side, the main research question of the thesis is to investigate the impact of sending SMS feedback to health worker, more than the development of SMS feedback itself. Therefore, we see the SMS feedback module as a tool or enabler to allow the research, and we feel a fit-for-purpose prototype that meets the tool requirement would be sufficient to get the answer of the main research

question. Once the code is stabilized, we could start to see how we can integrate it back to DHIS2 as product at later stage and how the functionality may be applied to other countries' settings.

#### 5.1.2. Software solution

This section describes how the software solution is built. At high level, the solution consists of front end and back end parts. The front end takes care of presentation layer to user, or as user interface; whereas the back end takes care of the actual data query, data persistence, job scheduling and SMS sending. The detail of each part is elaborated in more detail below.

##### 5.1.2.1. Front End SMS Feedback Web App as User Interface

###### Server side vs client side user interface approaches

In DHIS2, there are two possible approaches in implementing user interface. The first approach is to develop user interface as a part of the server side module. This approach is typically used in core modules of DHIS2. In this approach, all user interface rendering functionality is coded in server modules and packaged as a part of the whole DHIS2 web archive file. The downside of this approach is that deployment of any change on user interface will require rebuild of the whole DHIS2 web archive file which requires application downtime for installation.

The second approach is to develop user interface as a web application running on client side (user's browser). In DHIS2 terminology, we normally call it as webapp. In this approach, all user interface rendering and business logic processing are performed locally on browser by using Java Script based application. The application is then bundled out in a zip file and stored unzipped in the server side. When the user wants to run the application, the required files will be downloaded and the business logics will be executed. The application will communicate with the server through HTTP/S calls to access and store data by sending request and getting response in JSON format. The advantage of this approach is that any change to user interface is independent from DHIS2 core package itself. The webapp can be modified and re-installed without down time. However, it has disadvantage over the requirement to transfer data back and forth between client and server, which may not be ideal in slow and unstable network connection.

### The chosen approach

Webapp (client side) approach is chosen due to its flexibility and also alignment with DHIS2 architectural strategy which encourages to move the business process logic to the client side as much as possible. The downside on the high network traffic to transfer data between client and server is deemed not a big problem, despite the WEMR server is actually hosted abroad in UK. It is because the SMS feedback user interface is only used for maintaining SMS template and schedule. So, that is just a one-time activity, whereas the regular SMS sending is all fully back end processing without any need for user intervention.

### Front end functionality

The front end is built mainly using AngularJS library. It has several functionalities from user point of view.

- Maintain SMS schedule. Here user can define new, edit existing, activate/deactivate existing or delete existing SMS schedule. When defining the SMS schedule user needs to specify:
  - The SMS recipient, which is linked to user group. This user group is part of DHIS2 standard feature. It is used to group several users, which ideally should have mobile number maintained per user.
  - The recurrence of SMS sending, whether daily, weekly, monthly, quarterly or yearly.
  - The data selection, which is linked to the recurrence. For example, if weekly recurrence is chosen, the data selection can be current week, last week, two weeks ago etc. This should be used in alignment with the reporting timeline/deadline, to ensure that SMS will have readily available data.
  - Start date and time, which is when exactly the SMS needs to be sent
  - End date and time, which is when the automatic regular SMS should cease sending
- Maintain SMS template. Here user can define new, edit existing, or delete existing SMS template. When defining the template user needs to specify:
  - Organization unit, that owns the data to be sent
  - Data element or indicator, which is essentially the data to be sent

- Any additional text that is deemed useful to provide context to the SMS

### SMS recipient vs organization unit

There have been discussions around how SMS recipient should be defined. The first option is to tie the SMS recipient to the chosen organization unit. This option has the advantage of making it easier to maintain the schedule without worrying about determining who the recipient should be, as the system will take care of the recipient determination automatically. Also, we can simply define one single template that will work for all organization units. However, it has several disadvantages. A person who is not related to the organization unit may have interest in getting the SMS, for example implementing partner (donor), supervisor at higher organization level, independent researcher etc. Other disadvantage is we cannot construct SMS that contains multiple organization units data, for example, league table that compares the performance of several organization units, both horizontally (peers comparison) and vertically (comparison against higher levels).

Second option is to let SMS recipient as independent entry from organization unit and user can freely define any user group with any member. This provides a lot more flexibility, allowing various types of SMS message, crossing multiple organization units either at same level or at different level. Finally the second option is chosen, due to the nature of the research that may need flexibility in different type of SMS message. Tying recipient to organization is an automation that makes solution more rigid and may not be generic enough to support the research flexibility and also compatibility with other potential test-bed settings (e.g. in non-Uganda WEMR scenario).

### SMS template format

SMS template is used as the basis for the actual message construction. We intend to make the template as easy to comprehend but still flexible enough to cater for various scenarios. At first we thought that it would be enough to place the data element or indicator in the template and move the organization unit as part of schedule's properties. However, that would not allow multiple organization units data in the single SMS, which may be valid scenario for league table kind of feedback.

We also thought that a scenario to compare current performance against past performance (i.e. multiple time horizons) might be good, to indicate trend. In this case the relative period would be needed as part of the template, instead of part of schedule, which makes the template will be more complex.

However, in the end, we decided to support comparison across multiple data elements or indicators, multiple organization units but not multiple time horizons. Therefore, SMS message to show trend is not supported at present.

The SMS template format in general is like below:

*Any-free-text* <**ou:org-unit-id-1;dx:data-element-indicator-id-1**>  
*any-free-text* <**ou:org-unit-id-2;dx:data-element-indicator-id-2**>  
...  
*any-free-text* <**ou:org-unit-id-N;dx:data-element-indicator-id-N**>  
*any-free-text*.

The <**ou:org-unit-id-N;dx:data-element-indicator-id-N**> is a pair of organization unit and data element (or indicator) that will translate into actual value. The free text is to provide the context of the message, for example to describe the data element name or organization unit name. At the end of the SMS message, the relative period will be appended to provide time context.

Sample SMS template:

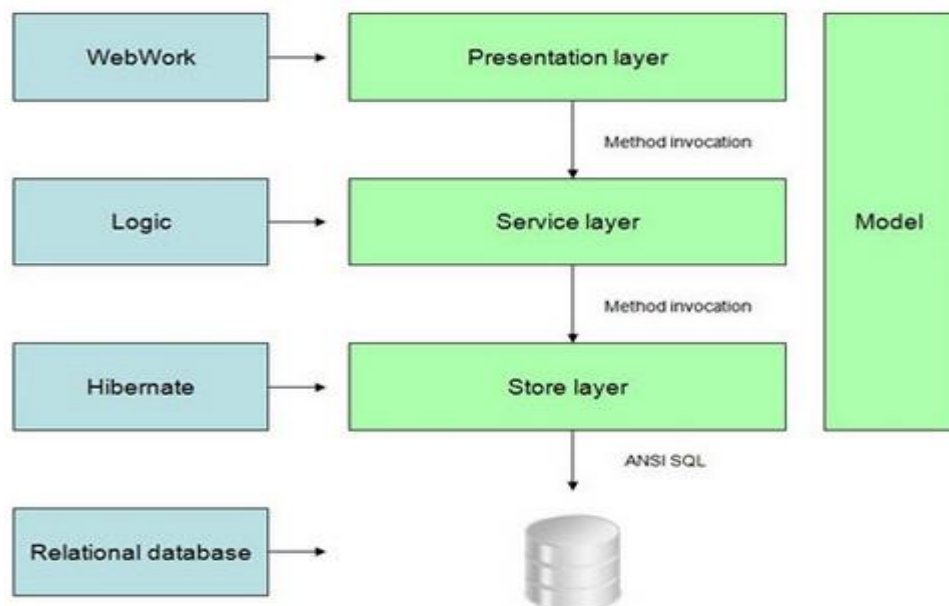
*Mulago New IVTest:ANC1=<ou:gQM4io94c2T;dx:sPCMdXM79tt>%,  
Drug Initiated:ANC1=<ou:gQM4io94c2T;dx:W8IT6uvdAfS>%,  
TRRK:ANC1=<ou:gQM4io94c2T;dx:JIxBv7nQF1M>%,  
TRR:ANC1=<ou:gQM4io94c2T;dx:SrdbwcKjinS>%,  
FeFo:AnyVisit=<ou:gQM4io94c2T;dx:JKHgCfE6mcf>%*

Sample actual SMS message result:

*DHIS: Mulago New HIVTest:ANC1=85.7%, Drug Initiated:ANC1=100%, TRRK:ANC1=25.5%, TRR:ANC1=2.2%, FeFo:AnyVisit=92.4% (2015W21)*

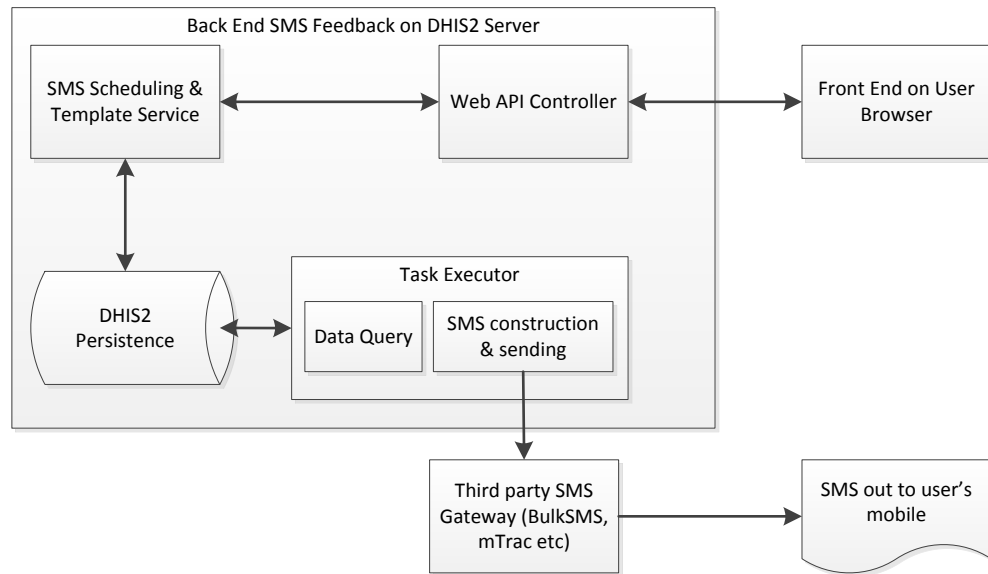
#### 5.1.2.2. Back End SMS Feedback Module Architecture

DHIS2 is written in Java and has a three layers architecture (see figure below as described on DHIS2 documentation web site), namely presentation, service and store/persistence layer. The back end SMS feedback module resides at service layer.



*Figure 9. DHIS architecture*

The back end SMS feedback has several parts. The first part is web API controller, which interacts with the front end request. The second part is the service that performs retrieval, creation and modification of SMS template and schedule from and to persistence layer. The third part is the executor service that performs the actual data query and SMS message construction as well as message sending.



*Figure 10: SMS feedback high level architecture*

#### Interaction with existing DHIS2 modules

DHIS2 has existing capabilities that support the SMS feedback. Some notable capabilities used in this SMS feedback module are:

- **Task scheduling.** After the schedule has been defined by user, the user needs to activate it in order for the system to schedule it. The user can also deactivate the schedule without deleting it, so it can be reactivated again in the future. DHIS2 has provided scheduling library that is based on Spring scheduler. This scheduling is also invoked when DHIS2 is starting up, so that the user does not need to re-activate the schedule manually when system is down and back up again.
- **Data analytic.** Based on the template defined by user, the active schedule will run on specified timing and start querying the actual value. The value can be data element or indicator. DHIS2 has existing data analytic library that can be used to query such aggregated data.
- **SMS service.** DHIS2 has built-in module to send and receive SMS. The DHIS2 SMS module can support various types of SMS gateway, including SMPP, modem, generic HTTP and pre-defined third party SMS provider. During development and early testing of SMS feedback, we used BulkSMS as the SMS gateway. However, when testing with WEMR we were advised to use mTrac, which is based on generic HTTP



type that utilizes Rapid SMS as the back end. This change of SMS gateway only requires a setting change in DHIS2 mobile configuration and no code change in SMS feedback module is needed.

- User group. As a part of standard DHIS2 capability, user group has been very useful for SMS feedback. It allows us to set up multiple SMS recipients in more standardized way. However, this will require all SMS recipients to be registered as DHIS2 user, which may create additional effort in registering many users, who actually may not access DHIS2 directly other than by SMS. However, looking at the future where mobile device is getting more affordable and the Internet is penetrating deeper (both wired and wireless/mobile), those users may start using DHIS2 actively. Therefore, it will create better environment for information culture cultivation.

## **5.2. SMS feedback pilot testing**

In this section, the pilot testing with WEMR setting is elaborated. It starts with infrastructure set up, scenario preparation and the execution itself.

### **5.2.1. Setting Up Infrastructure**

#### DHIS2 Test Instance

WEMR has DHIS2 production and test instances which are hosted in UK. At present those WEMR instances are on DHIS2 version 2.16. Whereas our SMS feedback module is developed based on version 2.17, which is one version later than WEMR. We think that the SMS feedback module should also work with version 2.16, but to avoid any implication with WEMR instances and bureaucratic approval to alter the system, we decided to set up our own DHIS2 instance as test system based on version 2.17.

The test system is hosted at University of Oslo, utilizing a virtual server which was previously used for group work of Open Source Development Course. Since the course is typically held in autumn semester, the virtual server is practically not used during SMS feedback pilot testing. After requesting for appropriate access and authorization, we were able to install the enhanced 2.17 version with our SMS feedback module. The test system is accessible at domain “inf5750-27.uio.no”.

#### Setting up WEMR Data in Test Instance

After several rounds of discussions and approval process with WEMR management, we eventually obtained permission to use WEMR data. One factor that complicated the lengthy approval process is due to the pilot nature of WEMR program. As it is still in pilot phase and still under evaluation, there has been concern over leaking of premature information to outsider and may have implication to the WEMR pilot itself. However it has been agreed that the focus of this thesis project is rather different from the focus of WEMR. WEMR is focusing on patient whereas this thesis is focusing on health worker. With that approval, we subsequently got WEMR database dump and managed to upload it to the test system.

However, it would not make sense to send SMS with snapshot data, because it might not be up to date and there would be no value to send obsolete information. We would need live WEMR production data. The challenge is how to synchronize test system data with WEMR production system. We looked at several options.

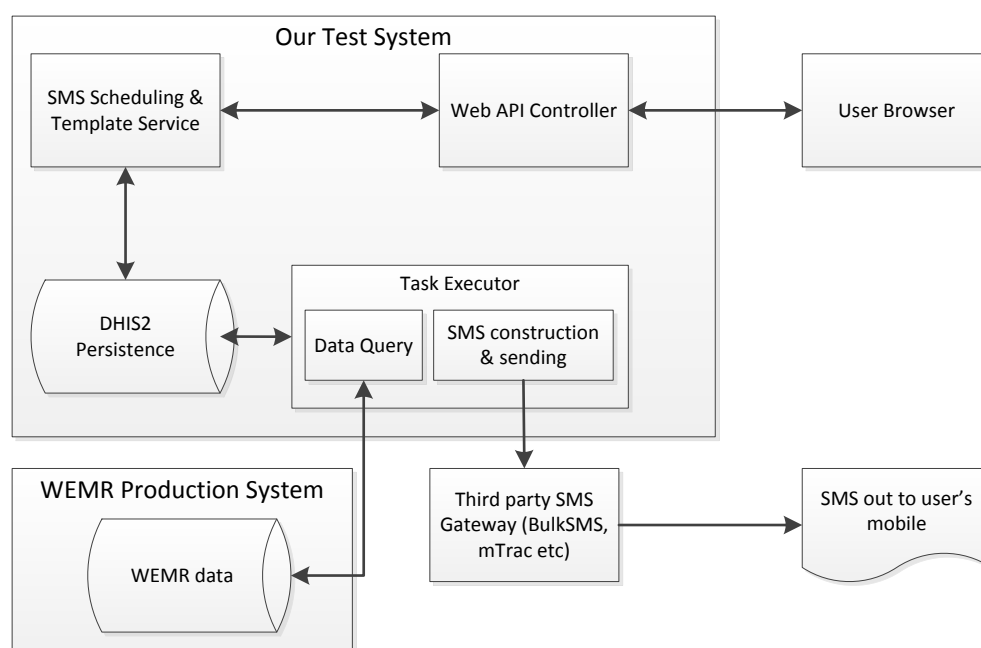
The first option is to utilize DHIS2 standard capability to synchronize data. It is a “push” synchronization approach, whereby the system which has the latest data should be configured to push to the system which has older data. The disadvantage of this approach is that we need to make configuration change in WEMR production system, which may not be allowed by WEMR management. After several rounds of trials between our test system and local DHIS2 instance in our PC, we found out it did not really work. We also got input from DHIS2 lead developer that if there are a lot of data changes, potentially there would be some data that would not be pushed. In addition, it does not push datasets, which is the core input from WEMR patient tracking. With those findings, we concluded that this approach is not feasible.

Second option is to apply manual download from WEMR production and upload to test system. This approach will ensure all latest data will be synchronized. However, the disadvantage is that it would erase all SMS schedule and template configuration that we have set up in test system, and we would need to re-configure them. It will be cumbersome when we have many templates and schedules. In addition, that would require close coordination with WEMR IT team to always send us latest database dump regularly, which may not be feasible for daily report. Even for weekly report, the week is ended on Sunday, so it necessitates manual work on every Sunday which may not be supported by

WEMR team. With those impracticality disadvantages, we dropped the approach as well.

The third option is to pull the data straight from WEMR production system when SMS is being constructed. In this case, the test system acts as the scheduler where business logic is performed, whereas the data source is located remotely in WEMR production system. The downside is the performance in which the remote query of the data will take more overhead in network traffic, compared to if we query the data from local database. However, based on our trials, the performance degradation is acceptable. Therefore, we eventually took this option. On the technicality, we introduced a configuration file, where we can specify the remote system detail with the credential. The positive side of this approach is that we can have flexibility whether we want to query a data from a local database or a remote one. Hence, virtually, we can segregate between the business logic system and the data warehouse system.

Below is the modified architecture to depict current testing infrastructure.



*Figure 11. Modified SMS feedback architecture for pilot test*

### 5.2.2. Setting Up Pilot Scenario

After establishing the test infrastructure, next step would be to set the scenario. The main questions are what feedback information to be sent, whom the SMS recipients are and at what frequency we want to send the SMS.

### SMS recipients and Frequency

WEMR program tracks the patient visit every day. Theoretically, we can send data of any period, from daily, weekly, monthly to yearly. However, we decided to take weekly as the frequency because of two reasons. Firstly, it does not make much value to send daily feedback as it would be too frequent and health worker may not have time to digest it, leading to information overload. Secondly, as this thesis study has time limit at months' time horizon, the monthly feedback frequency would be too slow in order to learn the impact.

As for the SMS recipients, we started with WEMR administrator and researchers first. The sending to health worker would require preliminary communication to them. So, only after we get input from the WEMR administrator/researchers and get a "go-ahead" signal, we would plan to send it to health worker.

### SMS feedback information

#### 1. First trial SMS with data elements (2 weeks)

At present, WEMR operates based on patient tracker. The patient tracker data can then be aggregated into data elements within the data set. At the first trial, we decided to send Weekly Antenatal Summary report. The antenatal report contains information about the number of 1<sup>st</sup> ANC, 4<sup>th</sup> ANC, 1<sup>st</sup> IPT, 2<sup>nd</sup> IPT, ANC attendance and re-attendance, as well as some numbers around HIV+ mothers.

The challenge we had was that the current Antenatal Summary Report takes raw data from the patient tracker. The report aggregates the raw data when it runs. The advantage of the approach is that it works with real time data. As soon as a patient visits the facility and get recorded, it will be counted in the report. The disadvantage is that the report takes longer time to pull all the raw data and aggregate it. Therefore, it has a potential performance issue, especially if we run it for wider data selection at the organization unit level or at the time period level. Using the same approach for SMS feedback will be too process-expensive. If we have thousands of SMS, we would need to do aggregation on-the-fly thousands time. To overcome it, we decided to create proper data elements and a query builder to translate from raw patient tracker data into data elements. The aggregation process will run weekly. The SMS feedback module will take the aggregated data from the data element, instead of the raw patient tracker data.

## 2. Second trial with indicators

After the first trial, it was perceived that sending the data element may not be very much of an added value to the health worker. That is because health worker may have known the value from their registers when submitting it to DHIS2. Sending an analyzed or calculated value is deemed more beneficial. Such calculated value is called *indicator* in DHIS2 terminology. However, WEMR system today does not use any indicator. As such, we would need to introduce some indicators that we think would be beneficial for the health worker to know.

The challenge was that WEMR team was not very sure of the kinds of indicator that will be the most appropriate because it was the first time for WEMR. Initial thought was to look at Uganda MoH weekly indicators. However, we felt it might not be necessarily relevant to WEMR because MoH indicators have relatively much broader focus than WEMR (which is specific to woman and child health).

After one week of discussion with WEMR team, the following six indicators were proposed:

- Percentage of new HIV test at ANC1 visit.

This indicator reflects the HIV test capacity of the health center. As Uganda has high HIV/AIDS prevalence, it is important to monitor the capacity to perform new HIV test upon first ANC visit. The higher number is better, which means the health facility is able to accommodate more HIV test. If the facility capacity is low, for example due to equipment or test kits stock out, this indicator may provide an indirect alert to prepare for.

- Percentage of woman initiated with drugs at ANC1 visit

This indicator describes two possible things, either facility capacity in providing drugs to woman who needs, or the number of woman with poor health so that she needs drug. High indicator value can be interpreted as good capacity in providing drugs (no stock out) or poor community health status (which causes more woman requiring drugs).

- Percentage of woman with known HIV+ at ANC1 visit

This indicator provides indication to the facility as to how much effort they need to take necessary treatment during ANC1. The higher value of indicator means health worker needs to do more HIV special treatment

in his/her facility. It can be interpreted as input for readiness in incoming weeks to prepare for.

- Percentage of woman whom is tested HIV+ at ANC1 visit

This indicator describes how much new HIV+ woman identified at ANC1 visit. Similar to known HIV+, this indicates the level of effort needed for special HIV treatment in future ANC visits for preparation purpose.

- Percentage of woman given iron/folic (FeFo) at any visit

This indicator describes facility capacity in providing iron/folic at any visit. Pregnant woman typically needs more iron. If natural diet does not provide enough iron, a supplemental iron will be given. Therefore the higher value of indicator means better facility capacity in providing the iron supplement.

- Percentage of missed appointment for HIV+ woman

This indicator describes the loss-of-contact, whereby the woman does not come for scheduled visits. This is especially important for HIV+ woman because she will need special treatment. The higher value of this indicator means bad thing, and it will need more follow up effort from health worker to contact the woman to come for visit.

After further investigation, the last indicator (missed appointment for HIV+ woman) was not possible due to technical limitation on how future schedule can be aggregated into data element. Therefore we proceed with the first five indicators for second trial.

Overall the indicators are related to PMTCT which was rationalized by WEMR officer inputs, despite some doubts if the chosen indicators will fit well for all type of health workers including mid wives (as opposed to doctors, nurses):

*“.. most guys who use data are PMTCT. I just hope they make sense to the mid wives..”*

*“.. but they [mid wives] have particular interest in PMTCT. The other indicators are require population as a denominator. The problem is the denominator. Otherwise this would be easy..”*

We discussed the option to get population from census bureau but the challenge is no census data at the level of facility catchment area.

*Researcher question: “Can we get it from Uganda statistics bureau?  
At least district population”*

*WEMR officer answer: “We only have 10 facilities. How will that make  
sense to a mid wife. That would make sense to say a district bio  
statistician”*

### 5.2.3. Execution of Pilot Testing

The first trial was conducted for two weeks for one facility (Mulago hospital). The SMS were sent only to WEMR officials whom were involved in this project. We did not send the SMS to health workers as we intended this for internal evaluation. Initially we used BulkSMS, but then it was agreed to use existing mTrac number 6767 because health workers are more familiar with that mTrac number. So they know where the SMS comes from and what it is about.

One issue was encountered during first trial, whereby the WEMR officials got truncated message after “@” sign.

*DHIS: MUL:ANC1=306 ANC4=17 IPT1=33 IPT2=22 TRRK@ANC1=20  
TRR@ANC1=3 TR&TRR@ANC1=3 RTST=0 REFIN=0 REFOUT=2  
REATT=203 TTATT=509 (201412)*

It appeared to be either problem with mTrac or the Uganda mobile operator that strips off “@”, because after changing “@” with “.” in the template, they managed to get full SMS text successfully.

*DHIS: MUL:ANC1=306 ANC4=17 IPT1=33 IPT2=22 TRRK:ANC1=20  
TRR:ANC1=3 TR&TRR:ANC1=3 RTST=0 REFIN=0 REFOUT=2  
REATT=203 TTATT=509 (201412)*

For the second trial with indicators, we started sending SMS to health workers. One step prior to that was to get informed consent from health workers to receive the SMS, as this participation is on voluntary basis. One WEMR officer provided a thought on that:

*“..I think It is necessary to talk to the mid wives to make sure they are  
willing to participate in this process, because they recently introduced*

*policy where individuals are allowed to unsubscribe to the unsolicited SMS. Also from my point of view although these midwives send data they do not really care much for it, to some it is just a task one has to do on a weekly basis, so I thought we are supposed to encourage information use by sending this automated feedback that is why the starting point is targeted to those in PMTCT because to them it is only about data entry but they are able to use this information for many more things..”.*

The expectation is, though this is voluntary, to spark a thought from health workers that the data they send every week is used and analyzed. The data is not lost or useless, and therefore this automated SMS feedback may help cultivating information culture among health workers.

The process of communicating and getting informed consent took around a week to get seven facilities on board, namely: Kisenyi, Muduma, Goli, Kawaala, Butoro, Mpigi and Mulago. After we had sent SMS feedback to those seven facilities for one month, we managed to get more facilities on board namely: Komamboga and Naguru. So in total, nine facilities have participated in weekly SMS feedback (at time of this report is written).

Below is sample SMS sent:

*DHIS: Mpigi HCIV New HIVTest:ANC1=89.1%, Drug  
Initiated:ANC1=66.7%, TRRK:ANC1=50%, TRR:ANC1=5.3%,  
FeFo:AnyVisit=98.8% (2015W21)*

This second trial has been running for 2 months when this report is written and still on going.

#### 5.2.4. Preliminary Evaluation of Pilot Testing

##### Software usability

We learnt that the software works relatively well. Every week the SMS has been constructed and successfully sent to mTrac addressed to all the recipients. This can be monitored from DHIS2 SMS log.



7	DHIS: Muduma HC III New HIVTest:ANC1=88.9%, Drug Initiated:ANC1=0%, TRRK:ANC1=0%, TRR:ANC1=0%, FeFo:AnyVisit=100% (2015W21)	[zikulah][prosper] [mudumahcii] [emma29]	SENT	May 26, 2015 10:32:06 AM
8	DHIS: Komamboga HC3 New HIVTest:ANC1=93.2%, Drug Initiated:ANC1=100%, TRRK:ANC1=7.1%, TRR:ANC1=1.2%, FeFo:AnyVisit=98.4% (2015W21)	[zikulah] [komambogahcii] [prosper] [emma29]	SENT	May 26, 2015 10:31:08 AM
9	DHIS: Mulago New HIVTest:ANC1=85.7%, Drug Initiated:ANC1=100%, TRRK:ANC1=25.5%, TRR:ANC1=2.2%, FeFo:AnyVisit=92.4% (2015W21)	[zikulah][prosper] [skamya] [emma29]	SENT	May 26, 2015 10:30:05 AM
10	DHIS: Mpigi HCIV New HIVTest:ANC1=92%, Drug Initiated:ANC1=100%, TRRK:ANC1=13%, TRR:ANC1=2.9%, FeFo:AnyVisit=100% (2015W20)	[zikulah][prosper] [emma29]	SENT	May 19, 2015 3:55:06 PM
11	DHIS: Kisenyi HC IV New HIVTest:ANC1=82.9%, Drug Initiated:ANC1=100%, TRRK:ANC1=21.3%, TRR:ANC1=3.9%, FeFo:AnyVisit=99.3% (2015W20)	[zikulah][prosper] [kisenyihciv] [emma29]	SENT	May 19, 2015 10:43:04 AM
12	DHIS: Naguru New HIVTest:ANC1=74.1%, Drug Initiated:ANC1=25%, TRRK:ANC1=2.9%, TRR:ANC1=5%, FeFo:AnyVisit=99.6% (2015W20)	[zikulah] [naguruhsop] [prosper] [emma29]	SENT	May 19, 2015 10:36:08 AM
DHIS: Butooro HC III New				May 19,

Figure 12. SMS feedback log

However, we could not really verify if mTrac manages to send to Uganda mobile operator and subsequently the mobile operator to deliver it to health workers. Based on input from WEMR officer, there was occurrence where mTrac was down.

*"I have been speaking with the facility staff about the SMS feed back, however they all say they have not been able to receive the messages.  
Well recently the 6767 code was off for some time."*

Therefore, while our WEMR SMS feedback has been 100% consistently sending the SMS, the end result to deliver SMS to health workers still depends on other two factors: mTrac reliability and Uganda mobile telecommunication reliability.



*Figure 13. SMS feedback message flow from WEMR to health worker*

The learning point here is that the external context where our case being studied may influence the end result. There is a little we can do when that happens as it is beyond our control. The fall back plan if mTrac has a problem is to switch the SMS gateway to BulkSMS, which theoretically should be more reliable as it is commercially supported by their IT support 24/7.

One area which was not fully operated by user directly is user interface (front end) part of the software. During this pilot we as researchers maintained the SMS schedule and template as per WEMR specification request. As we developed the front end ourselves, we did not get much difficulty in operating it. Certainly we might get different input from user which may not be familiar with the how-to, but we think that is more a training topic.

#### Questionnaire to health worker

After sending SMS, for two months we developed a questionnaire to get feedback from the health workers. Based on that feedback, we would try to interpret what impacts of the SMS feedback has to the health workers. Indeed, the impact will be very much interpretive, purely based on what the health workers think or feel, rather than a more objective field observation to see if the SMS really changes the way health workers do the jobs in any aspect. We took this approach because practically we could not expect observable drastic change within two or three months of pilot. Such hard evidence like motivation improvement and information culture cultivation would certainly need longer time period in order to be measured more objectively.

As we did not come to Uganda to get the questionnaire answered, we were helped by WEMR officer to circulate the questionnaire to the participating facilities and obtain the result back to us.

The questionnaire itself has several sections (detail on appendix):

- a. Profile of respondent

- Profession (e.g. doctor, nurse, mid wife, community health worker etc.), main duty of the profession and mobility aspect of the duty
  - Position in the team (leader vs sub-ordinate)
  - Level of facility where respondent works (national, regional, HC1, HC2, HC3, HC4)
- b. Work performance measurement situation
- Existence of quantifiable target for the job
  - Work performance situation (e.g. compared to target or to other facility)
- c. Adequacy of communication equipment & required infrastructure at work place
- d. Reporting existence and perceived benefit if any
- e. SMS feedback
- Perceived usefulness of the information being sent
  - Perceived benefit (to motivation, decision making, knowledge/awareness, others)
  - SMS frequency and suggestion on the contained information
  - Other free opinion

In the questionnaire, we tried as much as possible to avoid any private or personal information. The respondent profiling questions are only intended to understand the context of the response, because different profession, location, communication adequacy may provide logical correlation or explanation to the different responses of subsequent questions. For example, if the work location does not have mobile coverage, then it is sensible that the rest of SMS feedback questions becoming irrelevant. Another example, based on the respondent profession, we might understand better what kind of information that is more relevant, because not all profession needs exactly same information. The information need might be different by profession, or different by location, or even different by position (e.g. supervisor vs sub-ordinate may have different motive/interest).

The work performance measurement questions are intended to understand if there is any desire to put such information into the SMS feedback, to complement performance review process which could be already in place (or even not in place).

The last section is really to understand how health workers perception about SMS feedback, whether it is beneficial in any way or not at all. We put an open question

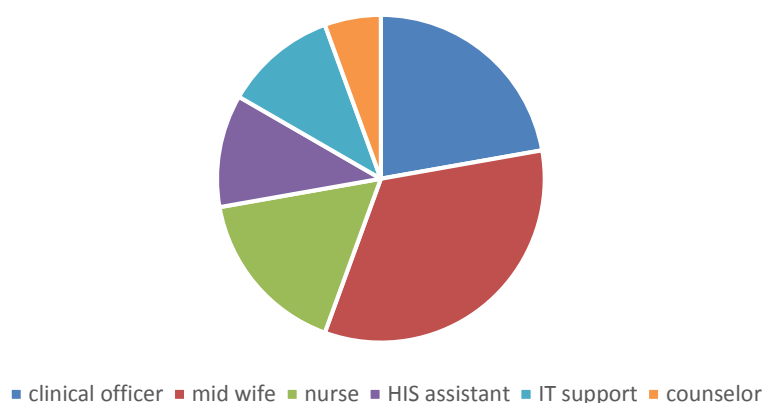
for a free opinion as well at the end to anticipate anything that we have not thought yet.

### 5.3. Result Analysis

This section details out the questionnaire results. We need to note that the result is qualitative in nature and might be subjective based on the respondent opinion.

#### Perceived impact based on questionnaire to health worker.

As starting point we discuss the profile of respondents to better understand the context of the answers. We obtained all nine participating facilities questionnaire results. The professions vary from clinical officer, nurse, mid wife, HIS assistant/IT support to health counselor. In terms of duties, they also vary from providing health care service, handling patient registration/administration, reporting and data analysis, patient counseling to providing IT system and user support. Hence from theoretical sampling, the respondent is fairly representative. What we do not have is doctor as respondent.



*Figure 14. Respondent profession*

All of the respondents are team leader/supervisor and therefore they are considered as senior staffs in their facilities. All of them work at either HC 3, HC4, regional hospital or national hospital. So, none of the respondent are from HC 1 or HC2, which are typically located in very remote area as the lowest level of health center in the system. Therefore, it is understandable that all of the respondent has no problem with mobile coverage and no issue with getting SMS delivered, since HC 3 facilities or above are located in relatively more urban area.

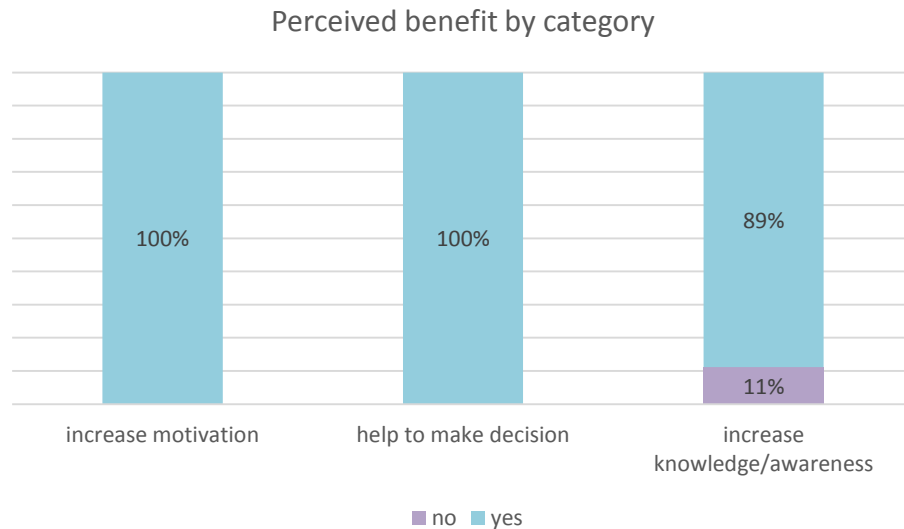
Despite of working at higher level of health center, the majority of respondents need to be mobile in their works, travelling every day or once a week. They need to travel for different purposes such as supervision, treating/educating patient, collecting data for

reporting, picking/delivering drugs, meeting or following up certain program activities. We also learned that Uganda Ministry of Health rotates the health workers from one facility to another for some reasons. Therefore, most of them use mobile devices in their works such as laptop, tablet, smart phone and mobile phone. Particularly, mobile phone is the one that is consistently used by all of them. They indicate that they have enough power supply to charge a mobile phone. This shows that using SMS as medium to convey the feedback fits well with the way they work as mobile workers.

The majority of respondents said that they have quantifiable target in their works and they know their performance level against those targets. That is a good thing as that means they work with certain sense of achievement in minds. However, only half of them know the comparison of their performance against their peers or other facilities at the same level. This indicates that performance competition or performance league comparison is either not always happening or perhaps is not disclosed to the health workers. When being asked if they want to know the peer comparison as a part of SMS feedback, all of them expressed their interests.

In reporting aspect, all respondent said that they did reporting in their jobs. They all acknowledged that reporting was beneficial to help them to improve in doing their jobs. However, we needed to critically note here that reporting is also an additional work to them on top of their duties in treating patients. So, the key point here is that: it is more work, but they reckon the benefit.

In terms of SMS feedback impacts, which is the main topic of this thesis, all of the respondent said that the information was useful. We asked in what way the usefulness was, the respondents chose “increasing motivation” (100%), “helping to make better decision” (100%) and “increasing knowledge/awareness” (88%). Hence, it was quite a positive response in general.



*Figure 15. SMS feedback perceived benefit by health worker respondent*

As this study is qualitative in nature, we got several textual feedbacks from the health workers. Majority of them were about the performance related response, which is not surprising as what we sent is indicator information that describes certain performance index. Firstly, they expressed acknowledgement that the SMS feedback had helped them to know how they performed, in the sense that it creates awareness among them. Some quotes from the questionnaire are shown below.

*“..help us to get to know our performance..”*

*“..was able to find out the performance of all facilities..”*

*“..I get the report of how we are performing on weekly basis..”*

*“..the sms are very useful because it would check where we are weak in reporting then improve. Keep it up..”*

Secondly, the responses indicated a desire to improve their performance. Such responses are closely related to their motivation to work better and subsequently hoping for better performance indicator values in next week SMS feedback. Few quotes are shown below.

*“..helps us to adjust accordingly for the better..”*

*“..the sms are nice and motivating and gives us a ground to improve for the better..”*

*“..we always get updated on our performance this helps to perform better..”*

*“..it rates our performance. With the increasing in client numbers it is in indicator of good services given to our clients..”*

*“the sms help us to improve on our weakness and try to make sure all the data is registered”*

*“very helpful in reminding people of their targets, help to find out what went wrong the previous week”*

From the above feedbacks, we are able to relate the responses to motivation and knowledge/awareness aspects of the anticipated impact as what we discussed in the literatures. However, it is not very clear how we can confidently relate the textual responses to the decision making aspect. One possible logic is that by understanding the weakness or shortfall against targets, the health worker would be able to focus or reprioritize their next week's tasks and therefore they can make right decision to support those better focused tasks. However, as we did not come to the field to ask further questions to clarify with health worker, we could not revalidate that logic. One example of the response that arguably can support that logic is shown as quote below, which indicates a decision making process to start ordering testing kits immediately based on the SMS feedback.

*“..I found out that some mothers were not tested, when I tried to find out why, it was due to lack of testing kits so there was need to increase amount of kits to be ordered..”*

Regarding the SMS feedback content, we got several inputs from the respondents on what content they wanted to be added. For example, one clinical officer respondent was keen to have “lost to follow up” indicator as he/she answered *“..the lost to follow ups, so that we can help the exposed babies that are lost..”*. A midwife wanted to have IPT, IPT2 and ANC 4th visits information to be added. On contrary, another respondent wanted to reduce the richness of information in single SMS as he/she suggested *“..decrease the number of message being sent to about one issue..”*. Perhaps the packed information in single SMS is not very much human readable. All those are valuable inputs which could be assessed further for the next round of SMS feedback submission.

The last but not least, we found out that in terms of frequency, weekly SMS was preferred by the majority of respondent (78%) compared to daily frequency (22%). This is fully understandable as in their daily routines the health workers have been very busy in treating patients. Therefore, sending too frequent SMS feedback could be too much and might not be digestible considering their workloads, and hence would lose

its effectiveness. Many reporting as the basis of feedback might be done in weekly basis as well, so sending daily feedback would not have sufficient data feed to support.

#### Perception from WEMR team

In general, we got a good feedback from WEMR team. Though we do not know as to how this SMS feedback would help WEMR project itself in meeting its objective, WEMR team appreciated the addition of SMS feedback functionality. One Uganda WEMR team expressed the appreciation and expected further improvement for localization as shown in the quote below.

*“Thanks for the great work and sharing the tool for feedback, my comments: The tools of okay on myside, MUJHU could only help with the language to tone it to the local setting”*



## 6. Discussion

In this chapter we discuss the findings and tie them back to the research questions. We start with discussing the sub research questions (as the enablers) and finally discussing the main research question.

### 6.1. Development of SMS feedback functionality in DHIS2

First sub research question is how we should develop the SMS feedback functionality. Since this project uses action research methodology, one of the key aspect is that the development of the software should be based on theoretical principles. As elaborated in literature review, bootstrapping and cultivation theory are very much relevant to this project context. We look at how each bootstrapping principle is applied in this project.

The first principle is “*design initially for direct usefulness*”, which means we need to start with small group, simple to use and offer direct benefit. In this project we approached Uganda WEMR programme and used it as the test bed, whereby the WEMR programme itself is still in pilot phase and has relatively small group size (i.e. 10 facilities in Kampala and Mpigi district). This has helped in formulating basic or minimum requirement/use-case in easier way and also foster relationship between the proposed SMS capability and user adoption. On the contrary, we could have approached Uganda MoH or other well established programmes with large user base, but that might cost us with more bureaucracy (i.e. in accessing and altering the system) as well as difficulty in discussion with so many parties to lock down the requirements which will slow down the study. So, this rule helps us in lowering the adoption barrier.

The second principle is “*build on installed bases*”, which means we need to utilize existing installed base as much as possible. In this context, we use existing WEMR DHIS2 system as the data source where we pull the data from and therefore user would be familiar with the nature of the data, reducing confusion in data interpretation. We also used the existing mTrac infrastructure to send the SMS, because the health worker had been familiar with the special number too. We simply connected the existing install bases with our new SMS feedback system, thus reducing the effort to support new systems.

From the capability perspective, as discussed in chapter five (findings), we also chose what is possible to be done in existing system and dropped what is not possible to be done, such as capability to provide recognition to health worker and his supervisor.

As DHIS2 is not HR system, there is no module that links between health worker and the supervisor to enable such automated recognition process. It was deemed to be too complex to build such module as part of SMS feedback functionality, so this capability was not explored further and we stick with what is available in existing system.

The third principle is “*expand installed base with persuasive enrollment tactics*”, which means after establishing the first usefulness, we need to sustain growth by persuading more user base to participate and extend the capabilities from there. Firstly, we use WEMR system as our test bed which is the existing infrastructure in Uganda with their existing users. However most users are using WEMR system in such a one-way traffic i.e. to submit reports. The development of SMS feedback can be seen as expansion with persuasive enrollment tactic to get more users into WEMR system i.e. now they get feedback out of WEMR system and may likely get more interested in exploring the available data there. Secondly, from the system capability point of view, the SMS feedback is clearly an expansion from the existing system capabilities by adding new functionality to send certain indicators. Also, based on the questionnaire after pilot testing, we got valuable inputs from health workers on what other information they want aside from existing indicators that we have sent, which will trigger more information needs and likely will expand user population whom has interest in WEMR.

The fourth and fifth principle are “*make the organization of IT capabilities simple*” and “*modularize information infrastructure*” for more adaptability. We try to make the SMS feedback solution low in technical complexity, for example we use single page for front end to maintain SMS template and SMS schedule. Also we make the capability modular by following loosely coupled principle. We build the software artifact in several layers as per DHIS2 architecture that will make it easier to adopt future evolution of requirement. We also separate between server-side back-end and client-side front-end, and use web app approach to pass the data, instead of using server-side only approach. Therefore if there is new capability needed on one side of artifact (either back-end only or front-end only), that would be easier to adapt without disturbing the other side. However we acknowledge that this approach may have downside in performance when the user’s Internet connection is not good (which could happen in Uganda) and may create some lag to transfer data between webapp and back-end.

From the above, we conclude that bootstrapping has been suitable and beneficial in approaching the development and pilot implementation of SMS feedback functionality where requirement is evolving and there has been existing system in place.

## 6.2. Determining appropriate feedback message

From chapter two (literature review) we learnt that there are various purposes of SMS based mHealth solution. The ones which are relevant to this project are the purpose of behavior change communication/education and supportive supervision. Both purposes have close relationship to health worker motivation improvement and information culture cultivation as objectives.

Franco [15] suggested that health worker's motivation is a complex process, which includes supervision/performance assessment processes to provide corrective feedback and encouragement to workers. Rowe [17] also argued that, based on cognitive theory, undesirable behaviors could be caused by a lack of information, and it can be improved by disseminating information on evidence-based guidelines. Whereas based on behavioral and learning theories, behaviors are a result of external stimuli and it can be improved by providing audit and feedback. A health management information system that includes indicators on quality of health-worker performance, routine supervision, and special surveys could help in establishing a quality improvement process.

In Uganda, the reality in the ground is that such supervision and feedback process may exist to some degree (such as weekly meeting), but not regularly/consistently held. There is an option to complement that irregular feedback process with SMS mechanism. But we need to note that this SMS feedback is not intended as a substitute of the existing formal supervision and feedback process, rather just a complement. That is because SMS is just one way traffic of information, without providing a venue for two ways traffic discussion.

Unfortunately, during the pilot testing of this project, WEMR team was not very sure of the kind of feedback message that would be the best fit to health workers to achieve supervision objective. The individual level of the feedback and supervision would not be possible at the moment, because DHIS2-based WEMR system is not a human resources information system. Therefore, we cannot really tell what each individual needs to improve or learn from DHIS2 data. The lowest level of information available

is only up to facility level. At the end, we agreed to use indicators per participating facility, so the feedback provided by the SMS is essentially a collective type of feedback for all health workers in that facility, rather than an individual feedback.

We need to note that a facility consists of many professions, such as doctor, nurse, mid wife, community health worker etc., with different interest and knowledge level. Therefore, we need to realize that the chosen set of five indicators used in the pilot may not fit to all health workers in the facility. How effective such generic/collective feedback will be something we would need to learn from time to time based on health workers input.

To have best benefit of such feedback, in my opinion, we need to tailor the feedback message differently by profession (or by duty), by facility or probably even by individual. Indeed that will require more effort by the system administrator to define multiple different SMS template, but that would fit exactly what every individual needs. In order to do that, first we would need to communicate to health workers about list of all information available in the system. The health workers then could choose which information he/she needs and provide reason why he/she needs it. Based on health workers input, then system administrator and health management team could formulate better suited type of feedback. The feedback may address different objective, such as to increase motivation (e.g. by providing performance comparison against peers average or target in the message), to increase awareness/knowledge (e.g. by providing important indicators in the message), to help decision making (e.g. by providing relevant indicators for his/her specific job in the message) or to cultivate information culture in general (e.g. by providing rich choices of information available that triggers more demand for information).

As an alternative to administrator- or management-controlled-feedback determination, in my opinion, perhaps in the future the health worker should be allowed to make his/her own feedback template independently, assuming the information is publicly available on the system. This is commonly known as subscription process. One thing we need to be careful is to control the cost of SMS in this case. One possible way to control is by giving certain credit limit per health worker, so he/she needs to consider the best SMS feedback for him/herself before making the choice to use up the credit limit.

### 6.3. Impact of sending SMS feedback

As stated in introduction chapter, our main research question is about how sending SMS-feedback to health workers involved in Uganda WEMR program impacts the way they work. In the questionnaire after pilot testing, we try to explore the impact based on participant's perception from several aspects: motivation, decision making and knowledge/awareness improvement. We need to note that the result is purely based on participant perceptions i.e. what they feel or think, rather than what we observe they really do or behave after the pilot testing i.e. observed behavioral change.

Regarding motivation aspect, the question of whether SMS feedback increases their work motivation has been answered positively by all participants. The question in questionnaire was formed as a 'Yes' or 'No' choice, with 100% answer of 'Yes'. While it was not immediately clear as to how it improves the motivation, we get some textual responses around their acknowledgement that the weekly indicator SMS has helped them to know their past week performances (sample responses: *"..help us to get to know our performance.."*, *"..I get the report of how we are performing on weekly basis.."* etc) and their desire to improve the next week performances (sample responses: *"..helps us to adjust accordingly for the better.."*, *"..the sms are nice and motivating and gives us a ground to improve for the better.."*, *"..it rates our performance. With the increasing in client numbers it is in indicator of good services given to our clients.."* etc). Therefore, we can argue that the increasing motivation aspect is mainly driven by the fact that now they know how well they perform and so they can reflect and focus on what area they can improve.

The above is actually part of feedback and supervision function within health information system, which we know that it does not always happen in regular basis in Uganda due to resource constraint and/or time constraint. The re-invigoration or re-establishment of regular feedback and supervision via SMS weekly feedback has been perceived positively by the participants. This is not surprising, because as suggested by Franco [15] from earlier literature review chapter, if we look at organizational aspect, health worker motivation is very much influenced by organizational feedback about performance. From the same front, it is also aligned with Rowe's [17] argument that a health management information system that includes indicators on quality of health-worker performance and routine supervision could help in establishing a quality-improvement process. However, we need to note that this SMS feedback should not be seen as replacement/substitute of existing face-to-face feedback mechanism, but rather as complement, especially when the face-to-face feedback mechanism does not

happen regularly. The SMS feedback is just another medium of conveying a performance report, which needs to be discussed with supervisor and to be actioned further.

Regarding decision making aspect, all participants answered “Yes” when being asked if SMS feedback helps them in the decision process. We understand that most of the participants are team lead/supervisor and have authority in making decision for their teams/functions. Again, we rely on the textual response to make sense of the result. Some sample responses indicated that decision making improvement claim based on the low number of mothers tested with HIV at ANC1 in the past week, as the participants said for example “..I found out that some mothers were not tested, when I tried to find out why, it was due to lack of testing kits so there was need to increase amount of kits to be ordered..”, “I have liked it. It has made me find out the problem and so I have gone ahead to find out the cause of the problem”. As the supervisor may not always be on the ground to sense the problem, the low figure on the SMS indicator has provided a trigger for him/her to look at that alert and go down to the facility to investigate further on the root cause and make necessary decision to rectify, in this case to start ordering more HIV testing kits. Had he/she not knew the low indicator value, the testing kits unavailability problem could have persisted even longer and undetected. This shows that regular and on-time feedback process is crucial to a timely decision making process. Waiting for a monthly report could be too late and may deteriorate the health service delivery further.

If we look back to the literature review, as suggested by Heywood and Rohde [8], this informed decision making is part of “interpret” and “use” process in health information cycle, whereby the indicator is interpreted by the supervisor to sense anything wrong with the result and subsequently use it to investigate the root cause and make decision. But we need to note that the use of information to support decision making and to drive the action does not always come easy. There are many cases where information is available but it is not used, which is described by Byskov and Olsen [9] as a “culture of reporting” rather than a “culture of using”. So this SMS feedback is still a preliminary step to make the information available on-time, but we have to agree that the “usage” of that information for decision making is highly dependent on the information recipient attitude/behavior and that is beyond the scope of this project. In short, this SMS feedback can help to facilitate decision making but not necessarily enforce the decision making to happen.

Regarding awareness/knowledge improvement aspect, the majority (89%) of the participants answered “Yes” when being asked whether the SMS feedback helps them raising their awareness/knowledge. Arguably, this is related to awareness of their own performances, as the information we sent during the pilot testing was mainly about their own facilities performance indicators. However, actually we can use this SMS feedback to convey many other informations not related to their own performances, but rather external to them; for example, indicator at province or country level with a purpose of raising awareness about how a certain MoH program or campaign has been progressing. Another example is when a certain outbreak happens in the country, it can help creating awareness of such issue. While this does not always directly help them in improving health service in their own facilities, such awareness may help in building knowledge and information culture among health workers.

Information culture will be the next step of this awareness/knowledge improvement from this SMS feedback. If the information awareness can be kept improving constantly, it will create information demand among health workers. They will be hungry for information that may help them in delivering the health service better, such as getting new knowledge or knowing how they perform against target or peers. However, culture building takes time and it will be beyond this project duration.

One point that we can highlight here is that the health worker now knows that the data that they submit is used/not wasted and even formulated into a useful indicator information back to them. This provides incentive for them to keep submitting report in quality and timely manner. As one of them said *“the sms are very useful because it would check where we are weak in reporting then improve. Keep it up.”*

#### 6.4. Challenges

##### Politics

As a context of the case study, politics certainly influenced the execution of this project. WEMR itself as our test bed is still in pilot phase. As a pilot project, the result and its effectiveness are still being evaluated and under close monitoring. Therefore, getting access and permission to use WEMR system is one important pre-requisite. WEMR project applies different research design compared to SMS feedback project. Within WEMR project, the intervention and the measurement criteria of situation before versus after had been well planned and anticipated as part of the project protocol, in the sense that certain positive results are expected based on the goals of

the project as approved by Uganda MoH. Hence the WEMR project is a type of theory testing research design from academic point of view.

From a political view, the WEMR project is expected to achieve its goal as promised in the project protocol. Therefore, WEMR project might be more vulnerable to external factors and hence it is understandably normal for a pilot project like WEMR to be cautious, to not let any confidential information released which could influence the outcome of the project. On the contrary, SMS feedback project is more exploratory in nature. We may expect either positive, neutral or negative result in any possible way (e.g. worker motivation, information culture, supervision etc.), not just in one particular aspect. One confusion during the process to get permission was the persons who are referred as participants in this SMS feedback project. WEMR as a project has the population/patient as participant, whereas this SMS feedback project has the health worker as participant. Therefore, the two projects actually have clear differences in research design, goal and participant as the research object, so while we use same/single system, politically the SMS feedback project is not expected to interfere or influence WEMR project. After providing clear explanation, at the end (within our one month), we managed to get the permission to access WEMR system and able to start the system setup for test.

### Ethics

Before starting the pilot testing we asked for health worker's consent to become voluntary participants. As one of WEMR officer said *"..I think It is necessary to talk to the mid wives to make sure they are willing to participate in this process, because they recently introduced policy where individuals are allowed to unsubscribe to the unsolicited SMS."* Since we used mTrac number 6767 for SMS feedback, the same number that is used by other Uganda MoH projects, we wanted to make sure that our SMS would not create a problem and make the health worker unsubscribe from mTrac. As we did not come to Uganda during the pilot testing, one of WEMR officer helped us in getting their consent instead.

In the interview and questionnaire, we also anonymized the respondent. We might collect data such as profession, the role or the nature of the respondent's duty, but we did not require the name, location or other private information. The purpose of those questions are mainly to understand the context or background of the responses. In addition to protecting the respondent, as this study is interpretive in nature, we acknowledge that what we perceive from the observation, interview and questionnaire, it might not be fully aligned with what the respondent is trying to



convey. As such, in case we observe a sub-optimum situation there, it should not be taken as individual respondent's fault.

#### Indirect interaction evaluation with health workers

After running the pilot test for more than two months, we tried to get input from the health workers about the SMS feedback. However, as we did not come to Uganda, we were unable to get first hand interaction with health workers to collect their inputs. As such, we developed questionnaire and requested WEMR team's help to circulate and obtain the result back. One challenge was that WEMR team has been loaded with normal works, therefore, we need wait for a bit longer time to get the result. Other challenge was that since this is indirect interaction, the health worker might have doubt or unclarity around what question being asked in questionnaire, and we could not come to explain. Therefore, whatever results we got is based on health worker's interpretation of what the questions mean, and based on what we interpret their responses are about. So it is two layers of interpretation, which creates a possibility of misunderstanding between the researcher and the respondents on the questions and answers.

#### Reliability of mTrac and/or Uganda telco system

We learned two things from our pilot. First, mTrac system is not always up, as based on WEMR team information it was down for some time, which caused our SMS feedback did not reach the recipients. Second, either mTrac system or the Uganda telco system sometimes truncates the SMS message when it contains certain character such as "@". There could be other character with the same truncation result, so that must be considered when constructing new SMS template. Both issues may affect the end result of the SMS feedback to recipient.

### 6.5. Contribution and limitation

As this thesis is based on action research/action case methodology, we expect that this project can contribute in providing solution to a real problem on field. From the observation, we understand that the problem on field is around the lack of regular feedback mechanism due to resource and/or time constraint. The health worker on the ground has been sending weekly report (at various levels of quality) but they do not always get regular feedback from what they have sent. As such, they do not always know how they perform and understand what area they need to improve; also, they do not always feel the real benefit of submitting the weekly report or in other words, they

are still at “culture of reporting” rather than “culture of using information”. They might think that sending report is just additional workload, rather than something beneficial to them.

After the implementation of SMS feedback in WEMR program, we show that using SMS as medium to convey feedback to the health worker is very much feasible, usable and technologically supported in such low resource context. We find out that the SMS feedback can complement existing feedback and supervision mechanism which does not always happen regularly today. Our SMS feedback functionality has provided performance indicator to each facility in timely manner that allow them to reflect and make necessary action for improvement. More importantly, the responses from health workers and WEMR management have been quite positive. The feedback from health workers show that the existence of such SMS feedback has increased their awareness/knowledge (at least awareness of their own current performances). It helped them to use that information to reflect and make informed decision, and motivated them to improve their future performance. This can be seen as a positive contribution of this study to solve practical problem on the field.

However, we need to note that this study is based on a small pilot within WEMR program, which is limited to nine facilities. Therefore, while the result has been positive within WEMR, we acknowledged that scaling up to wider scope may pose different challenge or result. As we know, Uganda has been using DHIS2 as country HMIS back bone, involving more than 7000 facilities nationwide (as quoted by one of Uganda CDC officer). Setting up and sending SMS indicator to 7000+ facilities on weekly basis has not been considered yet in this pilot.

We also acknowledged that the result is based on short term 2.5 months of pilot testing. The response that we get from questionnaire is purely based on what health workers perceive or feel from that short duration. The result is not based on long term observation of what we see have changed in terms of work motivation, health service delivery quality or any change in health worker behavior. As such, we reckon that this study is still lacking of hard evidence i.e. what we really observe has changed on field, instead of just what health workers think they have changed or will change. We understand as researcher we need to have critical view of not always trusting what the respondents say or think they do, but also to have objective view from what we observe the respondents really do. This observation will require longer duration which is not possible for this master thesis.

From DHIS2 perspective as a software artifact, we have added new capability to send SMS indicator which was not there before. Hence, it is also practical contribution to DHIS2, which potentially can be made as a part of standard package, after any necessary product review process. As we know DHIS2 has been used in many countries, having SMS feedback as a part of standard package will enable other countries to leverage the capability and apply it in their own contexts. However, as the limitation we also reckon that the use case we anticipated in this WEMR pilot may not accommodate other countries requirements, and therefore, some generification of the artifact may be needed.

From academic contribution point of view, this study shows empirical evidence that connects between the importance of feedback mechanism to health system and the feasibility of SMS as a medium to provide the timely feedback in low resource context. Individual theory as it stands alone (i.e. importance of feedback, and SMS feasibility in low resource context) has been well discussed in the literature review chapter. However, the application to connect between the two has not been much addressed by the existing studies. What we see close to this study is inSCALE project, but that has slight difference approach to this SMS indicator feedback as we have discussed earlier literature review. Therefore, this study may contribute in adding new empirical evidence in this context.

## 7. Conclusion

This chapter concludes the thesis by summarizing the findings to answer the research questions and what further research can potentially be done as the suggestion.

### 7.1. Addressing research objectives

Main research question in this thesis is to find out how sending SMS feedback to health workers involved in Uganda WEMR program impacts the way they work. In order to arrive at the finding of the main research question, there are several sub questions that need to be addressed first as the enabler.

The first sub question is about how we should develop the SMS feedback functionality in DHIS2 as software artifact. We conclude that segregating between the server side (back end) and the client side (front end) is the best suited approach that is aligned with DHIS2 architecture, whereby the service (implemented as Web API) and persistence layers are kept at server side. The presentation layer (implemented as Web App) is kept at client side. This approach allows flexibility for future enhancement.

Afterwards, since WEMR has been an existing system with its users and interconnected systems, it is important to understand what kind of strategy that we need to use to approach the development process to ensure it does not break the existing capabilities while adding new functionality. We concluded that bootstrapping strategy is very much appropriate by building on existing infrastructure (e.g. use or connect to existing systems), focusing design on direct usefulness and making the capability simple yet modular. We reckon that the WEMR DHIS2 system as our installed base should be seen as ever evolving infrastructure which we cultivate in on-going basis rather than revamp radically.

Subsequently, we conclude that sending SMS feedback containing analyzed or calculated value such as indicator is deemed more value-added than sending back data element to the health worker. It is also better to send the appropriate indicator to the level where the data is coming from (e.g. if the report is submitted by facility level, then the indicator should be calculated at facility level and sent back to the facility itself), to allow a better reflection and information use for supervision and decision making. The indicator itself should be made relevant to the recipient, for example, in WEMR context PMTCT indicators are deemed to be the most relevant type of information.

When implementing a study piggy-backing on a pilot project (such as WEMR) as a test bed, we conclude that several aspects need to be considered carefully to mitigate the challenge/risk. Sensitivity of the test bed project should be respected by making clear segregation of the goals, participants and concise explanation to the test bed project owner, as we should not interfere or risk the outcome of the test bed project. Ethics must be adhered and anonymity needs to be preserved. Another point, since our SMS feedback capability does not stand alone but rather interconnected to other existing external systems (such as mTrac and Uganda telco company) within the whole installed base infrastructure, the end result also depends on the reliability of those external systems, which sometimes can be beyond our control.

Finally, based on the findings, we conclude that sending indicator SMS feedback to WEMR health workers have been perceived positively. Firstly, it increases health worker's awareness/knowledge of their current performance. Secondly, the information helps them to reflect and make proper decision making. Thirdly, by knowing where they are weak in their past performance, it motivates them to improve for future. Those three points constitute closed loop feedback/supervision process which can be facilitated by SMS as a medium to convey the information. However, SMS should not be considered as a substitute of face-to-face feedback/supervision mechanism, but rather as its complement when a face-to-face mechanism does not always work regularly/timely. Lastly, the feedback process provides a good incentive for health workers to keep sending a quality and timely report every week, knowing that their submitted reports are really used and appreciated. By keeping such bi-directional information flows from and to health workers alive, we hope that information culture can be slowly cultivated in the long term and shift from "information for reporting" to "information for use" attitude.

## 7.2. Further research

This thesis study has several limitations which could be interesting points for further research.

Firstly, the solution is very much limited in terms of scale. It is not known whether the current solution will be practical to scale up for example to 7000+ facilities in Uganda. One area to improve could be the user interface, whereby we need to setup one SMS template and one SMS schedule per facility. Therefore, setting up country wide templates may not be practical for the administrator, unless there is a tool to facilitate mass maintenance.

Secondly, the finding is purely based on what health workers perceive based on 2.5 months pilot testing. That perception is more towards what they feel or think, rather than what we observe they really do or change after getting the regular SMS feedback. It will be interesting to come down to the field and conduct closer observation for longer time to see how the regular SMS feedback really impacts or changes the way they work.

Thirdly, the solution is designed for direct usefulness within Uganda WEMR context i.e. based on WEMR specific use case. While DHIS2 has been used in 47 countries, it will be interesting to see how we can make SMS feedback generic enough to accommodate other countries context. Obviously, the approach likely will not be a single grand design for all at once, but rather an evolution style of bootstrapping.

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## Appendix A. Questionnaire

Below is sample questionnaire result obtained from a facility health worker whom was involved in SMS feedback pilot. The summary of questionnaire result is also tabulated in separate pages underneath this sample questionnaire.

### Questionnaire to Health workers:

1. What kind of Profession do you have (e.g. Doctor, Nurse, Mid-Wife, Health Statestition, Community Health Worker etc.)?	
Counselor / midwife	
2. Duties for your profession (e.g. registering patients, providing health care services etc.):	
Coordinating Program activities Pre and Post test counselling of clients Infant feeding counselling Psychosocial support counselling	
3. Do you have subordinates (e.g. you are team leader or supervisor)?	
Supervisor	
4. Do you work at an:	
HC1	<input type="checkbox"/>
HC2	<input type="checkbox"/>
HC3	<input type="checkbox"/>
HC4	<input type="checkbox"/>
Regional-Hospital	<input type="checkbox"/>
National-Hospital	<input checked="" type="checkbox"/>

5. Does your work require you to be mobile? Move from one place to another.	
yes	
6. How frequently do you need to move (e.g. every day, every week, once a week etc.)?	
every day	
7. Why do you need to be mobile (e.g. treat patients, register patients, deliver report, education etc.)?	
educate and support staff on PMCT - picking drugs from the stores do follow-up on certain program activities. attend meetings which are off the site - deliver reports to relevant offices. Give feedback to my supervisor	
8. Do you have any quantifiable targets in your work?	
yes	
9. IF YES: Do you know your position to the target or goal? (e.g. below, middle or over target/goal)	
over target	
10. IF YES: Do you also know how your facility performance compares to other similar facility? (e.g. HC1 compared to another HC1 etc.)	
NO	
11. What kind of communication device do you have at work (you can choose multiple answers)?	
Laptop(PC)	<input checked="" type="checkbox"/>
Tablet	<input checked="" type="checkbox"/>
Smartphone	<input type="checkbox"/>
Mobile	<input checked="" type="checkbox"/>

12. Do you have enough electricity to charge devices (you can choose multiple answers)?	
Laptop(PC)	<input checked="" type="checkbox"/>
Tablet	<input checked="" type="checkbox"/>
Smartphone	<input type="checkbox"/>
Mobile	<input checked="" type="checkbox"/>

13. Do you do any regular reporting?
yes
14. IF YES: Do you think reporting is beneficial for your work (helping you doing your job better)?
yes it is beneficial because it helps me to identify my gaps

15. Do you have enough mobile coverage to receive SMS-messages at your workplace?	
Yes	<input checked="" type="checkbox"/>
No	<input type="checkbox"/>

We have sent five indicators on SMS to you. Example:

"Mulago New HIVTest@ANC1=78.6%, Drug Initiated@ANC1=0%,  
TRRK@ANC1=27.6%, TRR@ANC1=2.2%, FeFo@AnyVisit=100% (2015W15)"

16. Was the information useful?
yes
17. Motivate you more?
yes

18. Help you make decisions better?
yes
19. Increase your knowledge/awareness?
yes
20. Not useful, but don't mind getting the information, why?
21. Not useful, don't want to get the information anymore, why?
22. Others, unexpected benefits or drawbacks from getting the information or make any difference in the way you work?
I get the Report of how we are performing on weekly basis.
23. Do you see other information that can be useful?
<p>expected mothers to come for CH<sub>4</sub> and chemistry results in that week where they were given appointment</p> <p>→ No 9 couples tested, Repeat test done</p>
24. Are you interest in knowing your facility performance compared to:
Other facilities?
yes



District average?
yes

25. Is SMS a useful way of obtaining information about your work (performance)?
yes it give one updates on particular activities carried out.

26. Do you see any problems by using SMS as a medium?
NO

27. Was frequency of receiving weekly SMS sufficient?
yes

28. What kind of frequency do you think is best to receive SMS (e.g. Daily, Weekly, Monthly etc.)?
weekly

29. It would be nice if you can write your opinion about the SMS's you have received and how you perceive it? Both negative and positive remarks are good information.
The SMS's have been helpful, I have been able to get updates on how we are performing on weekly basis.

	_FAX201506051010.PD	_FAX201506051013.P	_FAX201506051016.PDF	_FAX201506051756.PD	_FAX201506051759.PDF	_FAX201506051801.PDF	_FAX201506051804.PD	_FAX201506051806.PC	_FAX201506051809.PDF
	Health worker from facility 1	Health worker from facility 2	Health worker from facility 3	Health worker from facility 4	Health worker from facility 5	Health worker from facility 6	Health worker from facility 7	Health worker from facility 8	Health worker from facility 9
1. What kind of Profession do you have (e.g. Doctor, Nurse, Mid-Wife,	clinical officer	clinical officer/in charge	mid wife	nurse and mid wife	health information assistant	registered comprehensive nurse	mid wife	IT support	counselor/midwife
2. Duties for your profession (e.g. registering patients, providing health care services etc.):	providing health care services	providing health care services	registering patients, providing health care services	registering patients, providing health care services etc	compiling report, registering patient, analyse data, sending report	providing health care services: examination of mothers, delivering mothers, immunizing	providing health care services, registering patients (mothers)	database management, offer IT support to midwives	coordinating program activities, pre and post test counseling of
3. Do you have subordinates (e.g. you	Yes	Yes	yes	team leader &	yes	in charge ANC	team leader	yes, supervisor	supervisor
4. Do you work at an: HC1, 2, 3, 4,	HC3	HC3	HC4	regional hospital	HC3	HC3	HC4	all	national hospital
5. Does your work require you to be mobile? Move from one place to	Yes	Yes	Yes	no	yes	no	yes	yes, supervisor	yes
6. How frequently do you need to move (e.g. every day, every week, once	every day	every day	every day		daily	nil	every day	once a week	every day
7. Why do you need to be mobile (e.g. treat patients, register patients, deliver report, education etc.)?	supervision	to supervise subordinate staff	treat patients, education		collecting data		treat pregnant women, register, educate mother, make report	support supervision	educate and support staff on PMTCT, picking drugs from the store, do follow up on certain program activities, attend meetings
8. Do you have any quantifiable	yes	yes	yes	no	yes		yes	yes	yes
9. IF YES: Do you know your position to the target or goal? (e.g. below, middle	middle	over	middle		middle	yes	middle	middle	over target
10. IF YES: Do you also know how your facility performance compares to	no	no	yes, during meetings with the records team	yes	yes	yes	no		no
11. What kind of communication device do you have at work (you can choose multiple answers)? Laptop/PC,	tablet, mobile	laptop, tablet	laptop, smartphone, mobile	laptop, tablet, mobile	laptop, tablet, mobile	laptop, mobile	laptop, mobile, tablet		laptop, tablet, mobile
12. Do you have enough electricity to charge devices (you can choose	laptop, tablet, mobile	laptop, tablet	laptop, smartphone, mobile	laptop, tablet, mobile	laptop, tablet, mobile	laptop	tablet, mobile		laptop, tablet, mobile
13. Do you do any regular reporting?	yes	yes	yes	yes	yes	yes	yes	yes	yes
14. IF YES: Do you think reporting is beneficial for your work (helping you	yes	yes	yes	yes	yes	yes	yes	yes	yes it is beneficial because it helps me
15. Do you have enough mobile coverage to receive SMS-messages at	yes	Yes	Yes	Yes	Yes	Yes	Yes	yes	yes
We have sent five indicators on SMS to you. Example: "Mulago New HIVTest@ANCI=78.6%,									
16. Was the information useful?	yes	yes	yes	yes	yes	yes	yes	yes	yes
17. Motivate you more?	yes	yes	yes	yes	yes	the information helps me assess the work	yes	yes	yes
18. Help you make decisions better?	yes	yes	yes	yes	yes	TRUE	yes	yes	yes

## Summary of questionnaire result



	_FAX201506051010.PD	_FAX201506051013.P	_FAX201506051016.PD	_FAX201506051756.PD	_FAX201506051759.PD	_FAX201506051801.PDF	_FAX201506051804.PD	_FAX201506051806.PE	_FAX201506051809.PDF
	Health worker from facility 1	Health worker from facility 2	Health worker from facility 3	Health worker from facility 4	Health worker from facility 5	Health worker from facility 6	Health worker from facility 7	Health worker from facility 8	Health worker from facility 9
19. Increase your	yes	yes	yes	yes	yes	no		yes	yes
20. Not useful, but don't mind getting									
21. Not useful, don't want to get the									
22. Others, unexpected benefits or drawbacks from getting the information or make any difference in the way you work?	helps us to adjust accordingly for the better	I found out that some mothers were not tested, when I tried to find out why, it was due to lack of testing kits	help us to get to know our performance			it is good to receive the information because it trace the lost to feed them in the book		was able to find out the performance of all facilities	I get the report of how we are performing on weekly basis
23. Do you see other information that can be useful?	yes, track women using sms. <some unclear comment>	the lost to follow ups, so that we can help the exposed babies that are lost	no	yes	yes		yes	total number of lost come for CD4 and to follow up, total number of visit schedule	expected mother to chemistry results in that week where they were given
24. Are you interest in knowing your facility performance compared to:	yes	yes	yes	yes	yes	very much	yes	yes	yes
25. Is SMS a useful way of obtaining information about your work	yes	yes	yes	yes	yes	yes	yes	yes	yes it gives our updates on
26. Do you see any problems by using SMS as a medium?	no	no	no	no	yes (?)	no	no	its limit to the amount of information one can receive	no
27. Was frequency of receiving weekly	no	yes	yes	yes	yes	yes	yes	yes	yes
28. What kind of frequency do you think is best to receive SMS (e.g. Daily, daily	daily	daily	weekly	weekly	weekly	weekly	weekly	weekly	weekly
29. It would be nice if you can write your opinion about the SMS's you have received and how you perceive it? Both negative and positive remarks are good information.	the sms are nice and motivating and gives us a ground to improve for the better	I have liked it. It has made me find out the problem and so I have gone ahead to find out	we always get updated on our performance this helps to perform better	it rates our performance. With the increasing in client numbers it is in indicator of good	decrease the number of message being sent to about one issue	the sms are very useful because it would check where we are weak in reporting then improve. Keep it	the sms help us to improve on our weakness and try to make sure all the data is registered	very helpful in reminding people of their targets, help to find out what went wrong	the sms have been helpful. I have been able to get update on how we are performing on

### Summary of questionnaire result (continued)

## Appendix B. Software artifacts

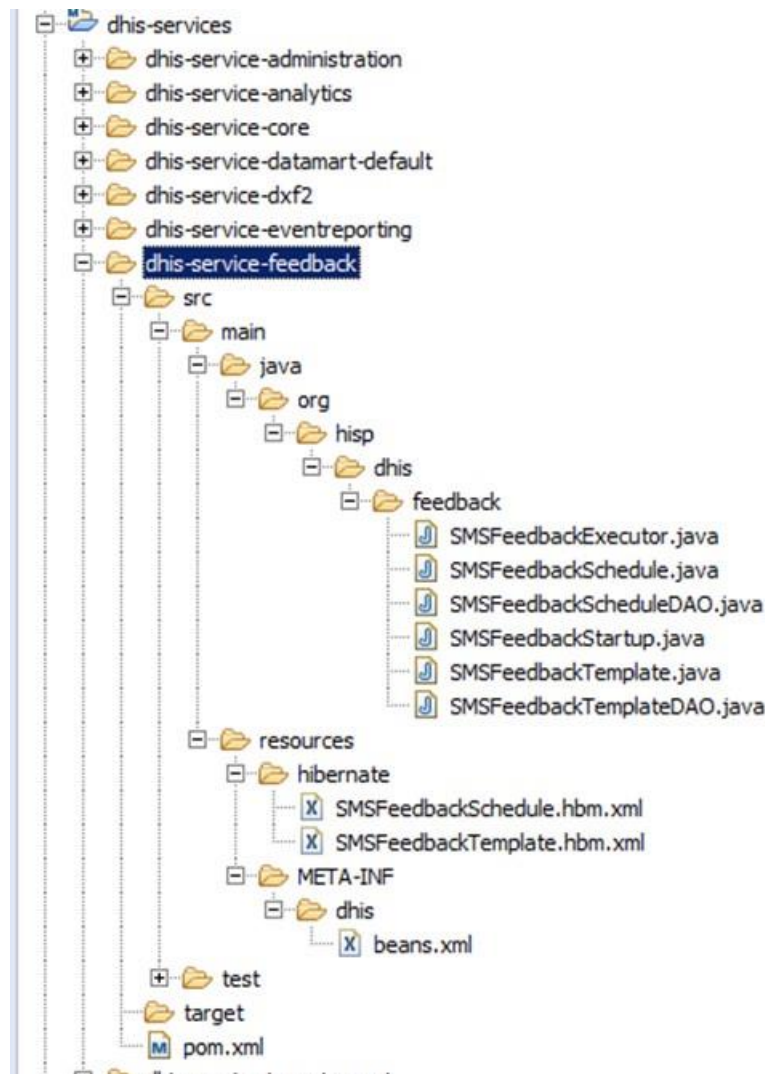
The SMS feedback in this thesis consist of back end at server side and front end at client side (browser). This SMS feedback software artifacts were co-developed between myself and Torbein Rein, whereby I wrote the back end at server side and he wrote the front end part.

### Back end

The back end at server side itself consists of two portions:

- 1) Service-feedback, which is responsible for doing most of the logics in handling SMS template maintenance, schedule maintenance, task execution and scheduling, as well as data access to persistence layer to update and retrieve the data objects.

Below is the structure of the service-feedback source code files within DHIS2 services module.

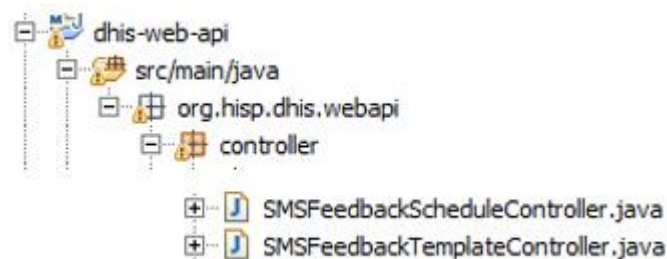


- a. SMSFeedbackExecutor is a runnable class which is responsible for parsing the SMS template, convert the parameters into indicator's actual value by calling

aggregation function, build the actual SMS message and send the SMS via the existing SMS sender class.

- b. SMSFeedbackSchedule and SMSFeedbackScheduleDAO are two classes which are responsible for lower level data access to persistence layer for SMS schedule object.
  - c. SMSFeedbackTemplate and SMSFeedbackTemplateDAO are two classes which are responsible for lower level data access to persistence layer for SMS template object.
  - d. SMSFeedbackStartup is class that is responsible for registering the active schedule into DHIS2 cron scheduler during system start up.
- 2) Web API controller, which is responsible for taking the HTTP request from front end (at client side), calling the service layer to update or get the data, and return the result back to front end in JSON format.

Below is how the web API controller is structured.



SMSFeedbackScheduleController handles SMS schedule maintenance (new, edit, delete, activate/deactivate), whereas SMSFeedbackTemplateController handles the SMS template maintenance (new, edit, delete).

### Front end

The front end at client side is mainly built based on AngularJS. The most important parts are controllers.js and services.js files. The services.js is responsible for interacting with the server's web API by sending HTTP request and getting the response in JSON format. Whereas the controllers.js is responsible for the logics to manage the resources obtained by services.js and present it into user interface in the web browser.

Some user interface screenshot examples:

1. SMS schedule maintenance (new, edit, delete, SMS preview)

**dhis2** Feedback DHIS2

Schedule Task ▾ Template ▾

New Schedule Task  
Existing Schedule Task

**Existing Schedule Tasks:**

**Title:** Kawaala HC3 ANC1, ANC4, ANC New Enrollment

User Group: Feedback Message Recipients

Trigger: Monthly

Template: Kawaala HC3 ANC1, ANC4, ANC New Enrollment

Start Date: 2015-03-29 08:36

End Date: 2015-04-01 08:35

Status: **ACTIVE**

Deactivate Delete Edit SMS Preview

**dhis2** Feedback DHIS2

Schedule Task ▾ Template ▾

**Edit Schedule Task:**

Organisation Units: Kawaala HC III

Uganda  
Central Division  
Kampala District  
Kawaala HC III  
Mulago Hospital  
Komamboga HC III  
Kisenyi HC IV  
China Uganda Naguru Hospital  
Nakasero Hospital  
Mpigi District

Data Elements: Search...

ANC 1st Visit  
ANC 4th Visit  
ANC New Enrollments  
BCG doses given  
Daily 1st ANC  
Daily 4th Visit  
Daily No of study participants  
Daily Total ANC visits

**Title:**  
Kawaala HC3 ANC1, ANC4, ANC New Enrollment

**User groups:**  
Feedback Message Recipients

**Recurrence:** Monthly **Data Selection:** Six months ago

**Start date and time:**  
2015-03-29 08:36

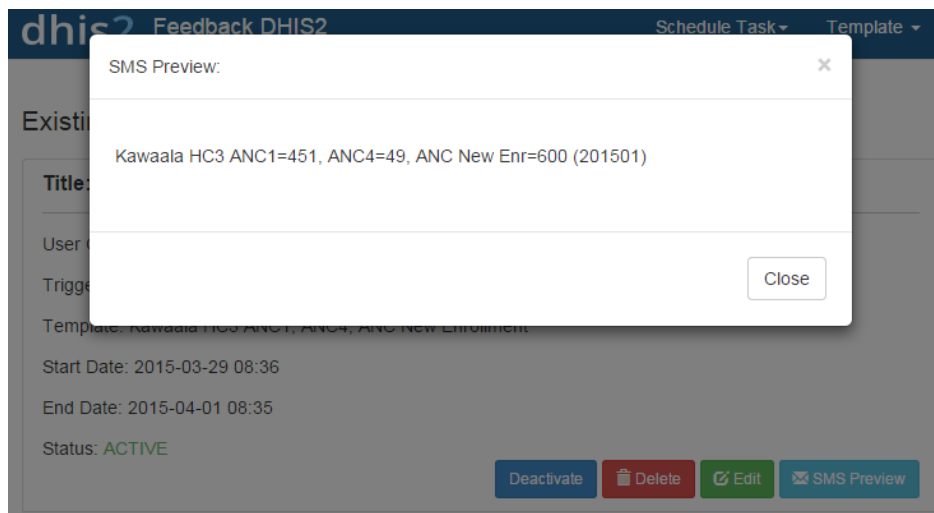
**End date and time:**  
2015-04-01 08:35

Edit template. Chose existing template.

**Title:**  
Kawaala HC3 ANC1, ANC4, ANC New Enrollment

**Message:**  
Kawaala HC3 ANC1=<ou.XfYrzq4LOWb:dx:MzHsnGfVf>, ANC4=<ou.XfYrzq4LOWb:dx:OZq7FusufQQ>, ANC New Enr=<ou.XfYrzq4LOWb:dx:EVQv8lO4xPA>

Cancel Save



## 2. SMS template maintenance (new, edit, delete)

dhish2 Feedback DHIS2

Schedule Task ▾

Template ▾

Existing Template:

Title: Kawaala HC3 ANC1, ANC4, ANC New Enrollment

Message:

Kawaala HC3 ANC1=<ou:XfYrzq4LOWb;dx:MzHsnGftVIF>, ANC4=<ou:XfYrzq4LOWb;dx:OZq7FusufQQ>, ANC New Enr=<ou:XfYrzq4LOWb;dx:EVQy8IO4xPA>

Delete

Edit

Title: Mulago Antenatal Weekly

Message:

MULAGO New HIVTest@ANC1=<ou:gQM4io94c2T;dx:SPCMdXM79tt>%, Drug Initiated@ANC1=<ou:gQM4io94c2T;dx:W8IT6uvdAfS>%, TRRK@ANC1=<ou:gQM4io94c2T;dx:JlxBv7nQF1M>%, TRR@ANC1=<ou:gQM4io94c2T;dx:SrdbwckjinS>%, FeFo@AnyVisit=<ou:gQM4io94c2T;dx:JKHgCfE6mcf>%

Delete

Edit

New Template

Existing Template

100

dhis2

Feedback DHIS2

Schedule Task

Template

Title: Kawaala HC3 ANC1, ANC4, ANC New Enrollment

Organisation Units:

Uganda

Central Division

Kampala District

Kawaala HC III

Mulago Hospital

Komamboga HC III

Kisenyi HC IV

China Uganda Naguru Hospital

Nakasero Hospital

Mpigi District

Data Elements:

Search...

ANC 1st Visit

ANC 4th Visit

ANC New Enrollments

BCG doses given

Daily 1st ANC

Message

Kawaala HC3 ANC1=<ou:XfYrzq4LOWb;dx:MzHsnGftVIF>, ANC4=<ou:XfYrzq4LOWb;dx:OZq7FusufQQ>, ANC New Enr=<ou:XfYrzq4LOWb;dx:EVQy8IO4xPA>

## Data model

We use two tables at database level, namely `feedback_schedule` and `feedback_template`. The template table is used to store the SMS template which will serve as the textual base to generate the actual SMS message content. The SMS template contains which organization unit id and which indicator/data element are used for certain SMS message. That table also controls the data selection range, whether the data to be pulled is current period, past N-days, past N-weeks etc.

The `feedback_schedule` table is used to store the schedule task, the SMS recipient (which is connected to DHIS2 user group), organization unit id, the beginning and ending date of the schedule, recurrence (daily, weekly, monthly etc.), the schedule task status (active vs inactive) as well as the scheduling repetition expressed in cron statement. The two tables are linked with `template-id` as the foreign key.

Table 1 - feedback_schedule		Table 2 - feedback_template	
field name	field description	field name	field description
schedule id	unique id for schedule task	template id	unique id for SMS template
template id	unique id for SMS template	template title	SMS template title
schedule title	schedule task title	template text	SMS template containing all parameters
SMS recipient	SMS recipient as DHIS2 user group (contains multiple DHIS2 users)	data selection range	current, past N-days, past N-weeks, past N-months etc
begin date	begin date/time of schedule task in cron		
end date	end date/time of schedule task in cron		
recurrence	daily, weekly, monthly, quarterly, yearly		
org unit id	org unit where the schedule task is applicable		
cron expression	scheduling expressed as cron statement		
status	active or inactive		